# 1994 Juvenile and Adult Coho Salmon Enumeration Studies at Black Creek, Vancouver Island

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# 1994 JUVENILE AND ADULT COHO SALMON ENUMERATION STUDIES AT BLACK CREEK, VANCOUVER ISLAND

by

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1996

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Coho smolts leaving Black Creek between April 22 and June 3, 1994 were trapped, adipose clipped, and coded-wire tagged (marked). A total of 78,282 smolts were captured at an enumeration fence and 77,872 of these (99.5%) were marked and released downstream. There were no flood events during the period of fence operation in the spring of 1994 and, due to the extremely low water levels during this period, the likelihood that smolts passed through or around the fence is low. However, it is likely that a number of smolts migrated from Black Creek during the first two weeks of April during a freshet event that peaked on April 10, and that some additional unmarked smolts emigrated from Black Creek after the last day of fence operation on June 3. A low number of coho fry (37) were caught in 1994, and 37 (100%) of these were successfully adipose clipped, tagged with half-length coded-wire tags, and released. Smolt mortalities due to trapping and tagging were low (0.43%) in 1994. All smolt data were stratified into three predetermined sampling periods. The calculated freshwater age structure of coho smolts was 96.6% age 1 and 3.4% age 2. Both the length and weight of migrating age-1 smolts decreased significantly between the first and second sampling period. There was a significant difference between the ratio of male and female smolts (1.5:1) for all sampling periods combined.

Coho escapements to Black Creek in 1994 were monitored by an adult enumeration fence operated between October 23 and December 16, and by conducting mark-recapture and carcass surveys upstream of the fence from November 15 - December 23. Flood events forced the fence to be lowered on two occasions (November 9-13 and December 23-30). Population estimates based on the pooled Petersen method were considered biased high in 1994 due to unrepresentative sampling during upstream mark-recapture surveys. Final escapement estimates (900 adults and 1500 jacks) were within the 95% confidence limits calculated for the pooled Petersen estimates (1144 adults and 2083 jacks). The final estimates were derived from a review of run timing data and the mark-recapture data that produced the pooled Petersen estimates, and a consideration of the minimum (known) number of fish in the system above the enumeration fence (599 adults and 1274 jacks). The mean postorbital-hypural lengths of adult male, female, and jack coho were 464 mm, 513 mm, and 275 mm, respectively. Female coho were significantly larger than adult male coho. Adult males were more numerous than females; the total number of males (adult plus jack) outnumbered females by more than 5:1. All of the successfully aged adults spent one year in freshwater, and a high proportion of successfully aged jacks (94.6%) spent one year in freshwater.

## RÉSUMÉ

Nelson, T. C., J. R. Irvine, and R. E. Bailey. 1996. 1994 juvenile and adult coho salmon enumeration studies at Black Creek, Vancouver Island. Can. Manuscr. Rep. Fish. Aquat. Sci. 2356: *x* + 67 p.

Les smolts de coho quittant le crique Black entre le 22 avril et le 3 juin 1994 ont été piégés; on leur a coupé la nageoire adipeuse et implanté une étiquette codée. Au total, 78 282 smolts ont été capturés à une barrière de dénombrement, dont 77 872 (99,5 %) ont été marqués et relâchés en aval. Il n'y a pas eu de crues pendant la période de fonctionnement de la barrière au printemps 1994, et, à cause du niveau extrêmement bas de l'eau pendant cette période, il est peu probable que des smolts aient pu franchir la barrière ou la contourner. Il est toutefois vraisemblable qu'un certain nombre de smolts ont émigré du crique Black pendant les deux semaines d'avril à cause d'une crue qui a connu son apogée le 10 avril, et que certains autres smolts non marqués ont quitté le crique après le dernier jour de fonctionnement de la barrière, le 3 juin. Un petit nombre d'alevins de coho (37) ont été capturés en 1994, et ils ont tous été marqués par implantation de demi-étiquettes codées et ablation de la nageoire adipeuse, puis libérés. La mortalité des smolts due au piégeage et au marquage a été faible en 1994 (0,43 %). Toutes les données sur les smolts ont été stratifiées en trois périodes d'échantillonnage prédéterminées. La structure par âge en eau douce des smolts de coho a été établie à 96,6 % d'âge 1 et 3,4 % d'âge 2. La longueur et le poids des smolts d'âge 1 en migration a baissé de façon significative entre la première et la deuxième période d'échantillonnage. On a noté un écart significatif dans le rapport des smolts mâles et femelles (1,5:1) pour toutes les périodes d'échantillonnage combinées.

Les échappées de coho du crique Black ont été surveillées en 1994 grâce à une barrière de dénombrement des adultes qui a été en service du 23 octobre au 16 décembre, et à des opérations de marquage-recapture et des relevés des carcasses en amont de la barrière du 15 novembre au 23 décembre. Des épisodes de crue nous ont obligés a descendre la barrière à deux occasions (du 9 au 13 novembre et du 23 au 30 décembre). Les estimations de population fondées sur la méthode de groupement de Petersen ont été considérées comme biaisées à la hausse en 1994 du fait que l'échantillonnage n'était pas représentatif pendant les relevés de marquage-recapture en amont. Les estimations finales des échappées (900 adultes et 1 500 jacks) se situaient dans la limite de confiance de 95 % calculée pour les estimations regroupées de Petersen (1 144 adultes et 2 083 jacks). Pour calculer les estimations finales, on a examiné les données sur le calendrier des remontes et les données de marquage-recapture qui ont donné les estimations de Petersen, et tenu compte du nombre minimum (connu) de poissons présents dans le système au-dessus de la barrière de dénombrement (599 adultes

et 1 274 jacks). La longueur moyenne post-orbite/hypuraux des mâles et des femelles adultes et des jacks était respectivement de 464 mm, 513 mm et 275 mm. Les femelles étaient nettement plus grosses que les mâles; le nombre total de mâles (adultes plus jacks) était plus de cinq fois supérieur au nombre des femelles. Parmi les poissons dont on a pu déterminer l'âge, tous les adultes ont passé un an en eau douce, de même qu'un bonne proportion des jacks (94,6 %).

## INTRODUCTION

This report presents results of the coho salmon (*Oncorhynchus kisutch*) smolt enumeration and coded-wire tagging study, and summarizes the adult coho fence count and upstream mark-recapture escapement studies at Black Creek in 1994. The main objectives of the program were to:

1) describe the size and age distribution of the coho smolts leaving Black Creek;

2) insert full-length coded-wire tags (CWTs) into coho smolts and half-length CWTs into emigrant coho fry;

3) obtain results required to examine the relationships between physical environmental factors and smolt and adult migration; smolt migration timing and size and subsequent oceanic harvest distribution; and adult escapement and smolt production;

4) estimate numbers of returning salmon and to collect coded-wire tagged heads from these fish; and

5) collect data on length, sex, maturity, and age at return.

Achieving these objectives involved the operation of fences to monitor the downstream migration of juvenile salmonids and the upstream movement of maturing salmon, counting all migrants, sampling lengths, weights, and ages of coho, and coded-wire tagging of as large a portion of the coho smolts and emigrant fry as possible. All smolt data were stratified into the three predetermined sampling periods used in Nelson et al. (1995), Nelson et al. (1994a), and Nelson et al. (1994b), the selection of which was based on data provided in Fielden et al. (1989), Bocking et al. (1991), and Nass et al. (1993b) to characterize the various phases of seaward migration.

## STUDY STREAM

Black Creek is a low-gradient (approximately 0.6%) stream on the east coast of Vancouver Island, B.C. (Figure 1). The system is approximately 26 km long, 5-6 m wide in its middle reaches, and has a catchment area of 72.5 $km^2$. For most of its length it meanders through agricultural land, small lakes, swampy areas, and beaver ponds. In the lower watershed, there are several tributaries including Millar Creek. Maximum discharges of 50-60 $m^3 \cdot s^{-1}$ have been estimated during floods. Black Creek supports populations of coho salmon, cutthroat trout (*O. clarki*), and steelhead trout (*O. mykiss*). Annual escapement estimates for coho are highly variable, ranging from as low as 749 adult spawners in 1987 to 15,000 in earlier years (Hancock and Marshall 1985; Clark and Irvine 1989; Labelle 1990). Coho spawn throughout the watershed, but the best spawning grounds are in Millar Creek, in mainstem areas adjacent to the Sturgess Road Bridge, and in the upper reaches in the vicinity of the Duncan Main logging road (Figure 1). Since 1978, and in those years when it was surveyed, the estimated coho smolt production from Black Creek has varied from a low of 29,776 in 1989 (Bocking et al. 1991) to 119,602 in 1990 (Nass et al. 1993b).

The juvenile and adult fish counting fences were located downstream of the Seaview Road bridge, in Miracle Beach Provincial Park. This location is above tidal influence. For the purpose of upstream surveys, the watershed was subdivided into six strata which contained 13 index reaches, each 250 m long (Irvine et al. 1992) (Figure 1). The locations of stratum boundaries were determined by tributary confluences and/or major transitions in stream gradient or some other habitat characteristic, and the index reaches were selected to be representative of the habitat within their stratum.

# SPRING FIELD STUDIES

## METHODS

### Fence Operations

The Black Creek smolt fence was constructed according to methods described by Conlin and Tutty (1979) using wooden-framed panels screened with 6.4 mm mesh steel hardware cloth. It was installed and operated as per Bocking et al. (1991), and Nass et al. (1993b). Plywood holding boxes with Vexar-screened windows to allow water exchange were anchored downstream of the fence to hold sorted fish from the trap boxes. The Black Creek smolt fence and holding facilities were operated from April 22 to June 03, 1994. Fry traps (1 mm mesh), similar to those used by Northcote (1969), were operated between the fence and the stream margins to monitor upstream movements of coho fry. A broomstick trap was also operated to capture upstream-migrating adult fish.

### Biophysical Monitoring

Weather conditions were monitored daily. Precipitation was ranked on a scale of 0 to 5 with 0 being no precipitation and 5 being heavy precipitation. Percentage cloud cover, wind direction, and wind speed were also noted. Water stage and water temperature were recorded automatically every three hours during the entire year using a Unidata 6003 datalogger. The datalogger was equipped with a Unidata 6508b hydrostatic pressure depth probe (0 to 3 m, +/- 0.012 m) and a 6507a thermistor temperature sensor (-1.2 to 45 °C, +/- 0.2 °C). The datalogger was installed approximately 200 m upstream from the Seaview Road bridge, well above the influence of the spring and fall counting fences. Unfortunately, the datalogger was vandalized and subsequently deactivated on October 17, 1995.

As a backup to the datalogger data, water temperatures and water levels were manually recorded during the periods of fence operation. Technicians recorded maximum, minimum, and present water temperatures (± 0.5° C) at the counting fence each day between 0800 and 0900 h using a max-min thermometer. Water levels were recorded daily using two staff gauges; one gauge was located beneath the Seaview Road Bridge (adjacent to the fence sites) and the other gauge was located approximately 200 m upstream at the automated datalogger station. An illustration of the relationship of daily mean water levels and temperatures throughout 1994 is presented in Figure 2. Data for Figure 2 were generated from

both the automated datalogger and manual records due to the loss of the datalogger on October 17, 1995.

**Trapping Efficiency**

Mark-recapture trials were used to estimate the catch efficiency of the enumeration fence and trap boxes. In 1994, two groups of smolts (n = 100 and n = 110) were anaesthetized using tricaine methane sulphonate (MS-222), given a unique caudal clip, and released between 100 and 200 m upstream of the fence. Throughout the entire trapping period, technicians monitored all smolts captured for recaptures from the trapping efficiency tests. All recaptures were recorded (recapture date, clip location), anaesthetized, adipose clipped, and coded-wire tagged (see **Coded-Wire Tagging** section) prior to release downstream of the fence.

**Fish Counts**

Each morning, all coho captured since the previous day were counted and sorted into groups based on their size. Coho smolts greater than 70 mm fork length were classified as either small (less than 120 mm in length) or large (greater than or equal to 120 mm in length). All coho less than or equal to 70 mm were categorized as fry. Any mortality due to capture, predation, holding, or tagging was recorded.

All non-coho fish migrating downstream were counted and released below the fence. We assumed that adult cutthroat or steelhead caught in the downstream traps were kelts (spawned out). All fin clips observed on non-coho species were recorded.

**Biosampling**

Random samples of up to 25 coho fry and 25 coho smolts were selected from each day's catch. These fish were anaesthetized in MS-222, measured to the nearest mm (fork length), and weighed using an Ohaus C305-S balance (± 0.1 g). Mean lengths and weights were calculated using random samples for all coho juveniles and stratified by age class and sampling period (Bocking et al. 1991; Nass et al. 1993b). Mean lengths and weights between consecutive sampling periods were compared for each age class using t-tests. A mean length and weight for the entire smolt population was calculated from random samples collected across all sampling periods.

Scale sampling procedures followed Ketchen's stratified method (Ricker 1975). During each sampling period (described below) we attempted to collect scale samples from 10 smolts in each 5 mm size class. Scale samples were not collected from coho fry. Smolts of the required sizes were selected from the catch to supplement the random samples when necessary. The calculated age-length distribution was used to determine the proportional representation of each age class within each sampling period; a chi-square test was used to detect differences between these proportions. Ages of smolts based on scale pattern analysis were reported using the European method of age designation, wherein age-1 smolts had one freshwater annulus, age-2 smolts had two freshwater annuli, etc. Scale samples were interpreted by personnel at the Department of Fisheries and Oceans Fish Ageing Laboratory in Nanaimo, B.C.

A total of 157 coho smolts from Black Creek were dissected to determine sex. Most of these fish were either trap or tag mortalities or fish sacrificed to determine CWT placement. Although the samples used for sex determination were not taken randomly, they were collected throughout the study period to minimize potential biases due to changes in sex ratios over the period of sampling.

**Coded-Wire Tagging**

Coded-wire tagging was performed by experienced taggers using a Northwest Marine Technology Ltd. (NMT) Mark IV tag injector. An MS-222 bath was used to anaesthetize smolts prior to tagging. The baths were changed regularly and recovery basins were repeatedly flushed with fresh water. All tagged fish were adipose fin clipped.

Since 1988, Black Creek coho smolts have been tagged using different tag codes to differentiate subsequent recoveries by sampling period and size. In 1994, sequential coded-wire tags were used exclusively for smolts to allow the stratification of releases by date. At the beginning and end of each tag code application, tagging technicians secured at least three tags from the spool in a data book. Later, the wire was decoded to provide unique "start" and "stop" sequences for each tag code, by date. In addition, smolts greater than or equal to 120 mm (large) and smolts less than or equal to 120 mm (small) were tagged with different codes (spools). Other data were stratified by the sampling periods used in previous years (up to May 10, May 11-June 02, and June 03 on). The majority of large and small coho were sorted by hand prior to being anaesthetized, but smolts that were close to 120 mm were sorted (measured) while under anaesthesia. The smolts from one of the size categories were then tagged while the other size category was held in a separate holding pen for tagging later in the day. This latter group of smolts included a small number of smolts that were subjected to two anaesthetic

baths. No differential mortality was observed between the two size categories over a 24-h holding period.

In total, there were nine different tag codes used for smolts at Black Creek in 1994. Coho fry were tagged with half-length CWTs, and the same tag code was used for fry tagging in all three sampling periods (Table 1). Tagging was done every day, except in a few instances when fish were held for two days before tagging. All tagged juveniles were transferred to a holding box and allowed to recover fully from the tagging operation before being released.

### Tag Retention

There were five tag retention checks performed on smolts in 1994, three for 24 h and two for 72 h. Approximately 100 fish were used for each test. Tag retention tests for fry were not conducted in 1994 due to the low number of fry available.

## RESULTS

### Biophysical Observations

Daily biophysical measurements are provided in Appendix A. Prior to fence installation, water levels were generally high and water temperatures increasing (Figure 2). A high-water event occurred from April 8-12, about 10 days prior to the first day of fence operation on April 22 (Figure 3). Water levels generally decreased following this event, and reached critically low levels in mid-May. Water levels stayed low through the last day of fence operation (June 3) and then through the summer (Figure 2). During the period of fence operation, water levels ranged from a maximum of 56.0 cm on April 22 to a minimum of 30.6 cm in late May; water temperatures ranged from a minimum of 10.5° C in late April to a maximum of 14.8° C in late May.

### Trapping Efficiency

The trapping efficiency of the fence was tested twice (Table 2). On May 16, 100 coho smolts were upper caudal clipped and released upstream; a total of 68 of this release group were recaptured (68.0%). On May 24, 110 smolts were lower caudal clipped and released upstream; a total of 71 of this release group were recaptured (64.5%).

**Fish Counts**

Coho Smolts

Total daily catches of juvenile coho are provided in Appendix B. A total of 78,282 coho smolts were counted at the Black Creek fence between April 22 and June 3 (Table 3). During this period, there were 151 pre-tagging mortalities (0.19%) and 75 smolts (0.10%) which either escaped during handling or were released untagged due to injury or poor condition.

The smolt migration was roughly unimodal (Figure 4). Significant catches began on 26 April during falling water levels, peaked sharply during a slight increase in water levels during May 5-8, and gradually decreased through the sampling period. Peak daily catches were observed following the slight increase in water levels on May 5 and May 7 (7672 and 7640 smolts, respectively). The period of fence operation appeared to cover most of the migration, although it is likely that some number of smolts migrated past the fence site prior to the first day of fence operation (smolts were captured on April 22, the first day of fence operation), and that some number of smolts migrated following the last day of fence operation (smolts were still leaving the system on June 3, the last day of fence operation).

Coho Fry

Daily catches of coho fry are given in Appendix B. A total of 151 downstream-migrating coho fry were caught at the fence during the study. A total of 20 upstream-migrating coho fry were captured in the fry traps below the fence; all were released above the fence.

Other Species

Daily catches of non-coho are presented in Appendix C and summarized in Table 4. Cottids were the most numerous non-coho captured, followed (in decreasing order) by wild (no clip) cutthroat smolts, wild steelhead smolts, wild cutthroat kelts, cutthroat parr, hatchery (clipped) cutthroat kelts, stickleback, hatchery cutthroat smolts, wild steelhead kelts, hatchery steelhead smolts, lamprey, and cutthroat fry, respectively. No upstream-migrating fish were captured in the broomstick trap in 1994.

**Biosampling**

Age

The calculated age-length distribution for wild coho smolts leaving Black Creek is given in Table 5. Age sample data (X) includes non-random samples; the calculated age representation (Y) is based on random sampling. The calculated freshwater age structure of Black Creek smolts (from all samples) was 96.6% age 1 and 3.4% age 2, and the age ratio of all age 1:age 2 smolts was 28.4:1. When compared between the first two sampling periods (there were no successfully aged samples in period 3), the age ratio of age 1:age 2 changed from 46.7:1 in period 1 to 21.1:1 in period 2, and the difference between these age ratios was significant ($\chi^2 = 4.59$, df = 1, $P<0.05$). No scale samples were taken from fry, but it is assumed that all fry were age 0+.

Length and Weight

The mean fork-length of the Black Creek coho smolt population was 121.5 mm and the mean weight was 18.44 g (Table 6). Individual length and weight measurements and the means of these measurements appeared to be normally distributed within sampling periods. Both the length and weight of age-1 smolts decreased significantly between the first and second sampling period (t-tests: length, $P<0.001$; weight, $P<0.001$). No age-3 smolts were identified in the random or non-random samples in 1994. The length-frequency distribution of successfully aged smolts is presented in Figure 5.

A comparison of the mean lengths of sampled fry between sampling periods was not conducted in 1994 due to the low number of samples.

Sex

A total of 157 Black Creek smolts were dissected to determine sex (Table 7). The proportion of male coho smolts was greater than that of female smolts during sampling period 1 (male:female ratio 1.4:1) and sampling period 2 (male:female ratio 1.6:1), and for all sampling periods combined (male:female ratio 1.5:1). The difference between the number of male and female coho smolts in the total sample was significant ($\chi^2 = 5.73$, $P<0.025$, df = 1).

## Coded-Wire Tagging

### Coded-Wire Tag Releases

A total of 78,056 coho smolts were coded-wire tagged using seven distinct sequential codes; a summary of specific sequences applied, by individual tag code, is provided in Appendix D. Of these tagged smolts, there were 184 known tagging-related mortalities (Table 1). A total of 37 coho fry were tagged with half-length tags, all of which were the same code. There were no known tagging-related mortalities of fry in 1994.

### Tag Retention

Tag retention tests were performed five times on coho smolts (three 24-h tests and two 72-h tests; Table 8). The mean tag retention rate for smolts was 97.6%. Tag retention tests were not conducted for fry in 1994 due to their low abundance.

# FALL FIELD STUDIES

## METHODS

### Biophysical Monitoring

Biophysical conditions were monitored and recorded as described in the earlier section of the report, Spring Field Studies.

### Coho Population Estimates

Counting Fence Operations

A collapsible adult counting fence was installed (Figure 1) prior to the first fall rains according to the methods and designs described in Labelle (1990) and Bocking et al. (1992). The fence was composed of a series of wood-frame panels with aluminum tube (2.5 cm diameter) insets spaced 2.5 cm apart. To increase the catch of small adult and jack (precocious male) coho, which were able to squeeze between the aluminum tubing, additional "jack panels" (mesh size 3 cm; Bocking et al. 1992) were placed on top of the main fence panels during low-flow and low-debris conditions. An aluminum-frame trap box was installed at each end of the fence; both trap boxes were operated when flows permitted.

Salmonids caught in the trap boxes at the counting fence were counted and the majority released upstream (a sample of adipose-clipped jacks was sacrificed for coded-wire tag recovery). All coho were classified as adult or jack, and the sex of each fish was recorded. All fin clips were recorded and degrees of maturity estimated (Bocking et al. 1992; Nass et al. 1993b). Any mortalities at the fence, either naturally occurring or due to handling, were recorded.

All coho released upstream were given a uniquely numbered Ketchum No. 1 operculum tag[1]. Operculum tags were applied to fish during transfer to a canvas cradle where fish were sampled for length and scales. Operculum tags were attached to specific, predetermined positions on either the left or right operculum (e.g., upper left, lower right) during flexible time periods (release groups) that corresponded roughly with pulses of fish at the enumeration fence. The rationale for the tag placement was for later determination of release group for fish captured

[1] Ketchum Manufacturing Sales Ltd., 396 Berkley Ave., Ottawa, Ont., Canada, K2A 2G6

upstream that had lost their operculum tag; the unique position of the tear on the operculum would allow positive determination of release group. The determination of release group for fish that lost their operculum tag would increase the sample size for the pooled Petersen estimate, which stratifies tag releases and recaptures by date (Arnason et al. 1996). All coho released upstream without a tag (escaped prior to tag application) were also recorded.

Mark-Recapture

In this report we refer to fish with operculum tags as tagged fish and adipose-clipped fish (fish that had been previously coded-wire tagged) as marked fish. Live coho were recovered upstream throughout the escapement period using electrofishing equipment. Most electrofishing surveys were conducted by blocking the downstream end of a recovery area with a small block net and then electrofishing the area. One person operated the block net, one person operated the electrofisher, and one or two people operated dip nets. The use of block nets greatly reduced the number of escaping coho.

All live untagged coho recovered upstream during surveys were also given a numbered operculum tag in a specific position on the operculum. Fish that had been previously operculum tagged but which had since lost their tag (identified by a tear on the operculum) were classified as primary recaptures; the position of the tear was recorded for these fish. All operculum tags applied at the counting fence were classified as primary tags; tags applied to untagged fish upstream were classified as secondary tags. In addition to a secondary tag, previously untagged fish captured upstream (referred to as "new fish") also received a single hole punch in the centre of the right operculum; this mark was applied in an attempt to positively identify recaptures of secondary tag fish that had lost their tag.

Mark-recapture estimates of escapement were generated using the pooled Petersen method. Standard errors (and confidence intervals) around the pooled Petersen were calculated using the Chapman hypergeometric model as described in Seber (1982, p. 60).

All coho captured during mark-recapture surveys were examined for operculum tags, evidence of tag loss, and the presence of a single hole punch in the operculum. Tag loss was recorded when clear evidence of tearing, due to the former presence of an operculum tag, was observed. The tear usually appeared as a straight slit in the operculum, approximately 0.5 cm in length. The position of the tag loss on the operculum was also recorded.

**Age, Length, and Sex Composition**

All live coho captured at the fence and during upstream surveys were measured for postorbital-hypural length (mm) and examined for fin clips, sex (adult males, females, and jacks), and maturity. Adult males and jacks were differentiated by a length delimiter of 350 mm (Bocking et al. 1992). Male coho less than 350 mm in length were closely examined for sexual dimorphic characteristics typical of spawning adult male coho (reddish sides, hooked jaws). Scale samples (Henry 1961) were taken from random captures of "new" coho (not previously handled), both at the fence and upstream. Ages based on scale pattern analysis were reported using the European (decimal) method of age designation (e.g., 2.1), wherein the first number is the number of freshwater annuli and the second number is the number of marine annuli. Scale samples were interpreted by personnel at the Department of Fisheries and Oceans Fish Ageing Laboratory in Nanaimo, B.C.

During upstream surveys, only "new" (previously untagged) coho were sampled for age, length, and sex. Maturities were recorded for both newly captured coho and for recaptured fish. Sex ratios were calculated from the total recovery sample of new live fish (fence and upstream). In 1994, average lengths were calculated for all new live recoveries (pooled sample of both fence and upstream recoveries) and were stratified by sex and age (adult or jack).

**Coded-Wire Tag Recoveries**

Adult and jack coho carcasses recovered were counted and the date and location of recovery, operculum tag number (if tagged), length, and any fin clips were recorded. Heads were removed from adipose-clipped carcasses, labelled with a unique number (E-label), and individually wrapped, and frozen. Data recorded for each carcass included date, recovery location, sex, length, maturity, any tag numbers, and other fin clips. Once counted, all carcasses were cut in half to prevent re-sampling during future surveys. Frozen heads were transferred to J. O. Thomas and Associates, Vancouver, B.C., where coded-wire tags were removed and decoded.

To determine the contribution of marked smolts from the 1993 and 1994 smolt emigrations to the 1994 escapement, we used the three-step process described in Bocking (1991) and Bocking et al. (1990). Assuming that the survival of unmarked fish was equal to or greater than that of marked fish, this method estimates the minimum contribution of each tag code to the escapement.

Adipose-clipped adult males, adult females, and jacks were counted separately. The estimates of total escapement of adipose-clipped coho was based

on the adjusted (see **RESULTS**) pooled Petersen population estimate of adults and jacks. The population estimate for all adult coho was apportioned into separate male and female population estimates using the calculated sex ratio observed in the total live recovery of new fish. Given an estimate of the total number of adipose clips for each sex and cohort escaping to the stream, the number of adipose clips for each tag code was estimated by the allocation of adipose clips to tag codes based on their relative frequency in the sample of decoded tags.

## RESULTS

### Biophysical Monitoring

Daily biophysical measurements are provided in Appendix E. Mean daily water temperatures and water levels during October, November, and December are presented in Figure 6. Daily water temperatures ranged from 8.0° C in late-October to 0.0° C in early December. Water levels in the fall of 1994 were generally low until the end of October. Flood conditions that forced the fence to be dropped (panels lowered) were encountered three times during the fall program in 1994. The first flood event occurred from November 9-13, the second from November 23-30, and the third and final event occurred on December 16 (the last day of fence operation). Peak water levels during the study period occurred in mid-December, and were followed by a sharp decline in early January 1995.

### Coho Population Estimates

Counting Fence

A summary of fence counts and associated operculum tag release data is provided in Appendix F. The adult counting fence was operated from October 23 through December 16. A slight increase in water levels on October 26 and 27 resulted in the first pulse of jack coho through the counting fence ($n = 333$) and 24 adults. A sharp increase in water level from October 30 through November 2 resulted in a second pulse of jacks ($n = 875$) and the only observed pulse of adults ($n = 512$).

From November 3-8 water levels were high and the fence was fully operational, yet the total number of fish observed was 10 adults and two jacks (all on November 4). The fence was dropped from November 9-13, during which time some number of coho passed the fence site undetected, as evidenced by captures of new (untagged) fish during upstream mark-recapture efforts on November 17

and 18. Due to the low counts of fish during high water levels from November 3-8, it is likely that a high proportion of the total run of adult and jack coho was observed and handled at the counting fence. The fence was operated during periods of medium-to-high water levels from November 14-22 and December 1-16 and no coho additional were observed.

Between October 22 and December 9, 563 adult and 1265 jack coho were captured at the fence (Table 9). The daily numbers of adult and jack coho captured at the fence are illustrated in Figure 7. Upstream migration peaked on October 30 for jacks and October 31 for adults. Of all coho captured at the fence, a single adult (male) and 38 jacks were sacrificed for coded-wire tag recovery, and two adults and two jacks escaped upstream untagged during handling; the remaining adults (n = 560) and jacks (n = 1225) were tagged with an operculum tag and released upstream.

Mark-Recapture

A summary of mark-recapture data is provided in Appendix G. Upstream foot survey and mark-recapture surveys were conducted between November 15 and December 23 (Table 10). A total of 48 live adult coho and 16 live jack coho were examined upstream; of these, 28 adults and seven jacks were new fish (not handled at the fence). Primary recaptures (fish that had been tagged at the fence) included fish that had lost the operculum tag. Tag loss rates for primary recaptures of adults and jacks were 5.8% and 6.3%, respectively. Tag loss may have resulted from improper attachment of the tag to the operculum, and tags becoming entangled in root wads and other debris and being torn off by the fish as it freed itself from the debris.

The pooled Petersen population estimate, and the minimum (known) escapements, are presented in Table 11. The minimum escapements of adult and jack coho above the enumeration fence in 1994 were 599 and 1274, respectively; the minimum escapements are the number of adult and jack coho released at the fence (does not include sacrifices) plus the number of "new" fish (untagged and no tag loss) handled upstream (in both the mark-recapture and carcass surveys; see Appendices F and G).

In 1994, the pooled Petersen estimate for adult coho was 1144, with lower and upper confidence limits of 831 and 1458, respectively (Table 11). For jack coho, the pooled Petersen estimate was 2083, with lower and upper confidence limits of 1296 and 2870, respectively. Due to high water levels it was not possible to conduct upstream mark-recapture surveys prior to November 15 (Table 10). The last date that fish were observed and tagged at the fence was November 4 (Figure 7). This meant that a significant proportion of the fish marked at the fence may have died by the time upstream surveys were conducted, which likely resulted in

the ratio of marked:unmarked fish upstream of the fence being unrepresentative of the total population. Escapement estimates based on these data would be biased high. The final escapement estimates (900 adults and 1500 jacks) are within the 95% confidence limits calculated for the respective pooled Petersen estimates (Table 11).

**Age, Length, and Sex Composition**

Figure 8 illustrates the length-frequency distribution of the escapement based on all live recoveries of new fish (fence plus upstream). Adult males ranged in size from 250-643 mm,($\bar{x}$ = 464 mm), females ranged from 281-644 mm ($\bar{x}$ = 513 mm), and jacks ranged from 208-347 mm ($\bar{x}$ = 275 mm) (Table 12). Females were significantly larger than adult males (t-test, $P<0.001$).

The total count of new adult male coho (n = 316) was greater than the total count of new female coho (n = 275) and the difference was not significant ($\chi^2$, $P>0.05$). When adult and jack males were combined, the total number of all male coho (1588) outnumbered females by more than five to one (Table 13).

The freshwater age distributions of the coho escapement are shown in Table 14. There were 51 scale samples aged successfully; however, all scale samples taken were resorbed to some extent. Results from the scale analysis indicate that all of the adults spent one year in freshwater, and that a high proportion of jacks (94.6% spent) one year in freshwater.

**Coded-Wire Tag Recoveries**

A total of 450 adipose-clipped adult coho and 1129 adipose-clipped jacks were observed among the total number of new fish handled at the fence and upstream (sacrifices included; Table 15). Based on the calculated mark rates observed in the total live recovery of new fish, (and our adjusted population estimate of 900 adults and 1500 jacks above the fence), we estimate that 76.1% (685) of returning adults and 88.8% (1331) of returning jacks were adipose clipped in 1994.

The percentage of smolts tagged in the springs of 1993 and 1994 that were recovered in the respective 1994 escapements of adult and jack coho varied among the tagging dates (Table 16). The total percentage of smolts tagged in 1993 that escaped to Black Creek as adults in 1994 was 1.23%. The total percentage of smolts tagged in 1994 that escaped to Black Creek as jacks in 1994 was 1.71%.

## DISCUSSION

In 1994, CWT releases of coho smolts totalled 77,872[2]; this number was 99.5% of the total number of smolts observed at the enumeration fence (78,282). Although it appears that the high majority of smolts that migrated from Black Creek in 1994 during the period of fence operation were counted and coded-wire tagged, the results of the trap efficiency tests suggest that a high number of smolts passed by the trap undetected (the combined trap efficiency for both tests was 66.2%). However, due to the extremely low water levels encountered in 1994, the likelihood that smolts passed through or around the fence is very low. Possible explanations for the low recovery of fish marked for trap efficiency tests include increased mortality of the marked fish due to low water levels, high water temperatures, and higher vulnerability to predation (due to the combination of handling and low water levels). Several thousand smolts were successfully captured and marked during critically low water levels in mid-late May 1994. Technicians at the enumeration fence noted that, during the low water period, almost all of the smolt movement into the trap occurred after sunset and before dawn. On many occasions, during a single night, several hundred smolts passed through water less than 3 cm deep in the "Big-O" tubing that led to the trap box.

It is likely that a high number of smolts migrated from Black Creek during the first two weeks of April in 1994 during a significant increase in water level that peaked on April 10 (see Figure 3). A similar event in 1992 resulted in over 9% of the total smolt count passing by the counting fence during the second week in April[3] (Nelson et al. 1994a).

The average lengths and weights of coho smolts that migrated in 1994 (121.5 mm and 18.44 g, respectively) were smaller than those that migrated in 1993 (132.4 mm and 25.89 g). Explanations for the smaller smolt size in 1994, as compared to 1993, include: 1) the higher number of smolts in Black Creek in 1994 could have resulted in more competition for food and prime rearing locations; 2) the summer rearing conditions in 1993 (1994 smolts) could have been better than in 1992 (1993 smolts); or 3) a combination of the above. Mortalities of smolts due to trapping and predation (0.19%) and tagging (0.023%) were low in 1994. Coho fry were observed infrequently and in low numbers at the enumeration fence in

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[2] Not corrected for tag loss; total tag loss was 2.367% for smolts in 1994 (see Table 8).

[3] In 1992, the smolt fence was operational on April 13. An increase in water levels on April 14 that peaked on April 17 resulted in a smolt count of 4553 from April 13-20. In addition, of all successfully aged smolts, over 16% of all age-2 smolts were observed at the fence during this April 13-20 period.

1994. A total of 37 fry were captured in the downstream trap at the fence, of which 37 (100%) were released tagged with half-length coded-wire tags.

The frequency of age-2 smolts in 1994 was lower than in previous years. It is very possible, though, that the majority of age-2 smolts that migrated from Black Creek in 1994 passed undetected prior to the period of fence monitoring (likely during a freshet event in early April; see Figure 3). Results of previous studies at Black Creek indicate that high portions of age-2 smolts migrate early in the migration (Nelson et al. 1995).

The minimum (known) numbers of adult and jack coho above the counting fence accounted for only 52.4% and 61.2%, respectively, of the pooled Petersen escapement estimates. At face value, these figures would indicate that nearly half of the returning fish passed by the fence site uncounted; the majority of these uncounted coho (the difference between the minimum escapement and the pooled Petersen estimate is 545 adults and 809 jacks) would have had to pass the fence site during the November 9-13 flood event. A detailed review of the run timing of coho at the fence site and the mark-recapture data used to generate the pooled Petersen estimate resulted in final escapement estimates of 900 adults and 1500 jacks. Confidence limits around the pooled Petersen estimates for adult and jack coho were 831-1458 and 1296-2870, respectively (Table 11); the final escapement estimates of adult and jack coho above the fence in 1994 fall within these confidence limits.

We tested for differences in length between adult male and female coho and found females to be significantly longer. This is consistent with previous studies at Black Creek (Bocking et al. 1992; Nass et al. 1993b; Nelson et al. 1994a; Nelson et al. 1994b; and Nelson et al. 1995). In the field, all male coho greater than or equal to 35 mm in length (postorbital-hypural) were classified as adult males.

Of the successfully aged adults that returned in 1994 (n = 14), none had spent two years in freshwater. A lack of age-2 freshwater representation has not been found in previous years but the 1994 sample size was small. Smolts that left Black Creek in the spring of 1993 (1994 adults) were 14.6% freshwater age-2 (Nelson et al. 1995). In 1993, 42.3% of the successfully aged adults had spent two years in freshwater (Nelson et al. 1995).

We calculated the percentage of migrating smolts in 1993 and 1994 that returned to spawn as adults or jacks in 1994, respectively, by dividing the estimated escapement of adipose clips, stratified by sex, by the number of smolts tagged (adipose clipped) and released in the respective migrating year. The number of smolts tagged and released in 1993 and 1994 was 55,565 and 77,872, respectively. The estimated adult escapement of adipose clips (calculated from the final escapement estimate (n = 685) represented 1.23% of the smolts released in

1993. The estimated jack escapement of adipose clips (n = 1331) represented 1.71% of the smolts released in 1994.

It is likely that some smolts migrated prior to the first day of fence operation, and that some smolts were downstream of the fence site when the fence was erected. The difference in the mark rate at release in 1994 (99.9%) and the mark rate of jacks at return in 1994 (88.8%) is likely attributable to some combination of the following reasons: 1) that a substantial number of smolts or fry migrated out of the system before and/or after the period of fence operation; and 2) that significant straying might be occurring from unmarked stocks.

1994 was the tenth consecutive year that Black Creek coho smolts were counted and coded-wire tagged and accurate escapement estimates were obtained. As the primary indicator for wild coho in the Strait of Georgia, data from this study form an integral part of the coho stock assessment process. Our knowledge of the production dynamics and spawning escapement requirements of coho increased considerably with the collection of information in 1994.

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# TABLES

Table 1. Coded-wire tag release data for Black Creek juvenile coho, by size group, 1994.

| Size group[1] | Tag code | Tagging dates | No. tagged | Tag morts | No. released tagged[2] | No. released untagged[3] |
|---|---|---|---|---|---|---|
| Small | | | | | | |
| | 080149 | 04/22 - 05/05 | 8312 | 7 | 8305 | 6 |
| | 080154 | 05/06 - 05/08 | 9777 | 92 | 9685 | 2 |
| | 080155 | 05/09 - 05/13 | 10122 | 1 | 10121 | 2 |
| | 080157 | 05/14 - 05/19 | 8922 | 3 | 8919 | 11 |
| | 080158 | 05/20 - 06/03 | 4638 | 4 | 4634 | 17 |
| | | Subtotal | 41771 | 107 | 41664 | 38 |
| Large | | | | | | |
| | 080145 | 04/22 - 05/02 | 10827 | 10 | 10817 | 6 |
| | 080147 | 05/03 - 05/05 | 8987 | 4 | 8983 | 4 |
| | 080148 | 05/06 - 05/12 | 9790 | 62 | 9728 | 14 |
| | 080156 | 05/13 - 06/03 | 6681 | 1 | 6680 | 13 |
| | | Subtotal | 36285 | 77 | 36208 | 37 |
| | | Grand total (smolts) | 78056 | 184 | 77872 | 75 |
| Fry | | | | | | |
| | 211411 | 05/09 - 05/17 | 37 | 0 | 37 | 0 |

Note: all small and large (smolt) tag codes are for sequential coded-wire tags

[1]small is < 120 mm; large is > = 120 mm

[2]not corrected for tag loss; total tag loss was 2.367% for smolts (see Table 8)

[3]No. released untagged = known escapees + fish released due to poor condition

Table 2. Results of trap efficiency tests conducted at Black Creek, 1994.

| Date of release | Number smolts released | Fin clip | Number recovered | Date of last recovery | Percent recovered |
|---|---|---|---|---|---|
| 05/16 | 100 | upper caudal | 68 | 06/03 | 68.0 |
| 05/24 | 110 | lower caudal | 71 | 06/02 | 64.5 |

Table 3. Coho smolt catches by sampling period at Black Creek, 1994. Mortalities include smolts killed by trapping and predation.

| Sampling period | Smolt size[1] | | Total (S+L) | Pre-tagging mortalities | Number released untagged[2] | Number available for tagging |
|---|---|---|---|---|---|---|
| | Small | Large | | | | |
| 04/22 - 05/10 | 27689 | 21858 | 49547 | 58 | 27 | 49462 |
| 05/11 - 06/02 | 8667 | 20034 | 28701 | 93 | 48 | 28560 |
| 06/03 | 6 | 28 | 34 | 0 | 0 | 34 |
| Total | 36362 | 41920 | 78282 | 151 | 75 | 78056 |

[1]small is < 120 mm; large is > = 120 mm

[2]No. released untagged = known escapees + fish released due to poor condition

Table 4. Total number of non-coho fish caught at the Black Creek smolt enumeration fence, April - June 1994. All fish were captured moving downstream.

| Species | Life stage[1] | Total number caught |
|---|---|---|
| Steelhead | smolt (H) | 7 |
| | smolt (W) | 378 |
| | kelt (W) | 8 |
| Cutthroat | fry | 6 |
| | parr | 192 |
| | smolt (H) | 13 |
| | smolt (W) | 422 |
| | kelt (H) | 157 |
| | kelt (W) | 210 |
| Cottids | - | 485 |
| Lamprey | - | 8 |
| Stickleback | - | 80 |

[1]H = hatchery (fin clip observed); W = wild (no clips observed)

Table 5. Age-length distribution of Black Creek coho smolts, by sampling period, 1994. Age representation was determined according to Ketchen's stratified subsampling method (Ricker 1975, p. 67).

| Sampling period[1] | Size class (mm) | Age sample (X)[2] | Ages in (X) | | Length sample (Y)[3] | Calculated ages in (Y) | |
|---|---|---|---|---|---|---|---|
| | | | Age 1 | Age 2 | | Age 1 | Age 2 |
| 04/22 - 05/10 | | | | | | | |
| | < 80 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| | 80-84 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| | 85-89 | 1 | 1 | 0 | 0 | 0.0 | 0.0 |
| | 90-94 | 10 | 10 | 0 | 2 | 2.0 | 0.0 |
| | 95-99 | 11 | 10 | 1 | 8 | 7.3 | 0.7 |
| | 100-104 | 12 | 12 | 0 | 25 | 25.0 | 0.0 |
| | 105-109 | 24 | 23 | 1 | 37 | 35.5 | 1.5 |
| | 110-114 | 20 | 20 | 0 | 52 | 52.0 | 0.0 |
| | 115-119 | 22 | 21 | 1 | 56 | 53.5 | 2.5 |
| | 120-124 | 14 | 13 | 1 | 67 | 62.2 | 4.8 |
| | 125-129 | 19 | 19 | 0 | 58 | 58.0 | 0.0 |
| | 130-134 | 12 | 12 | 0 | 59 | 59.0 | 0.0 |
| | 135-139 | 13 | 13 | 0 | 48 | 48.0 | 0.0 |
| | 140-144 | 9 | 9 | 0 | 28 | 28.0 | 0.0 |
| | 145-149 | 6 | 6 | 0 | 12 | 12.0 | 0.0 |
| | 150-154 | 9 | 9 | 0 | 12 | 12.0 | 0.0 |
| | 155-159 | 10 | 10 | 0 | 7 | 7.0 | 0.0 |
| | 160-164 | 2 | 2 | 0 | 4 | 4.0 | 0.0 |
| | > = 165 | 2 | 2 | 0 | 2 | 2.0 | 0.0 |
| | Total | 196 | 192 | 4 | 477 | 467 | 10 |
| | | | Percent of length sample (Y) | | | 98.0 | 2.0 |

Table 5. (cont.) Age-length distribution of Black Creek coho smolts, by sampling period, 1994. Age representation was determined according to Ketchen's stratified subsampling method (Ricker 1975, p. 67).

| Sampling period[1] | Size class (mm) | Age sample (X)[2] | Ages in (X) Age 1 | Ages in (X) Age 2 | Length sample (Y)[3] | Calculated ages in (Y) Age 1 | Calculated ages in (Y) Age 2 |
|---|---|---|---|---|---|---|---|
| 05/11 - 06/02 | | | | | | | |
| | < 80 | 2 | 2 | 0 | 2 | 2.0 | 0.0 |
| | 80-84 | 2 | 2 | 0 | 0 | 0.0 | 0.0 |
| | 85-89 | 5 | 5 | 0 | 1 | 1.0 | 0.0 |
| | 90-94 | 15 | 15 | 0 | 13 | 13.0 | 0.0 |
| | 95-99 | 20 | 19 | 1 | 47 | 44.7 | 2.4 |
| | 100-104 | 22 | 21 | 1 | 70 | 66.8 | 3.2 |
| | 105-109 | 33 | 33 | 0 | 94 | 94.0 | 0.0 |
| | 110-114 | 11 | 11 | 0 | 84 | 84.0 | 0.0 |
| | 115-119 | 18 | 17 | 1 | 89 | 84.1 | 4.9 |
| | 120-124 | 12 | 10 | 2 | 59 | 49.2 | 9.8 |
| | 125-129 | 9 | 9 | 0 | 37 | 37.0 | 0.0 |
| | 130-134 | 8 | 7 | 1 | 26 | 22.8 | 3.3 |
| | 135-139 | 11 | 10 | 1 | 17 | 15.5 | 1.5 |
| | 140-144 | 7 | 7 | 0 | 7 | 7.0 | 0.0 |
| | 145-149 | 3 | 3 | 0 | 6 | 6.0 | 0.0 |
| | 150-154 | 1 | 1 | 0 | 1 | 1.0 | 0.0 |
| | 155-159 | 1 | 1 | 0 | 1 | 0.0 | 0.0 |
| | 160-164 | 0 | 0 | 0 | 1 | 0.0 | 0.0 |
| | > = 165 | 0 | 0 | 0 | 1 | 0.0 | 0.0 |
| | Total | 180 | 173 | 7 | 556 | 528 | 25 |
| | | | Percent of length sample (Y) | | | 95.5 | 4.5 |
| | Grand total | 376 | 365 | 11 | 1033 | 995 | 35 |
| | | | Percent of total length sample (Y) | | | 96.6 | 3.4 |

[1]sampling period 3 (June 3 only) was omitted from this analysis because there were no successfully aged samples for this date

[2](X) = random and non-random samples

[3](Y) = random samples only

Table 6. Means and standard deviations for lengths and weights of Black Creek smolts, by age and sampling period, 1994. Data from successfully aged random samples only.

| Age | Sampling period | Fork length (mm) | | | Weight (g) | | |
|---|---|---|---|---|---|---|---|
| | | N | Mean | SD | N | Mean | SD |
| 1 | 04/22 - 05/10 | 93 | 127.0 | 18.04 | 93 | 21.50 | 9.134 |
| | 05/11 - 06/02 | 86 | 116.0 | 16.33 | 86 | 15.36 | 6.490 |
| | Total age-1[1] | 179 | 121.7 | 18.05 | 179 | 18.55 | 8.527 |
| 2 | 04/22 - 05/10 | 3 | 111.3 | 10.97 | 3 | 13.80 | 3.652 |
| | 05/11 - 06/02 | 4 | 120.0 | 13.49 | 4 | 16.75 | 6.371 |
| | Total age-2[1] | 7 | 116.3 | 12.35 | 7 | 15.49 | 5.218 |
| Grand total (all ages)[2] | | 186 | 121.5 | 17.87 | 186 | 18.44 | 8.437 |

[1]total means and standard deviations are calculated from pooled data across sampling periods
[2]total means and standard deviations are calculated from pooled data from all age groups across sampling periods

Table 7. Sex ratios and mean lengths of Black Creek coho smolts, by sampling period, 1994.

| Sampling period | Sex | Proportion (%) | Sample size | Mean length (mm) | SD length (mm) |
|---|---|---|---|---|---|
| 04/22 - 05/10 | Male | 58.0 | 47 | 115.3 | 10.4 |
| | Female | 42.0 | 34 | 112.4 | 16.3 |
| 05/11 - 06/02 | Male | 61.8 | 47 | 103.2 | 11.7 |
| | Female | 38.2 | 29 | 102.6 | 10.7 |
| Total[1] | Male | 59.9 | 94 | 109.2 | 12.6 |
| | Female | 40.1 | 63 | 107.9 | 14.7 |

[1]total means and standard deviations are calculated for pooled data across all sampling periods

Table 8. Coded-wire tag retention and loss rates for Black Creek juvenile coho, 1994.

| Life stage | Date | Hours held | Sample size | Number tags lost | Tag retention (%) | Tag loss (%) |
|---|---|---|---|---|---|---|
| Smolts | | | | | | |
| | 04/28 | 24 | 98 | 4 | 95.9 | 4.082 |
| | 04/29 | 72 | 101 | 0 | 100.0 | 0.000 |
| | 05/10 | 24 | 101 | 4 | 96.0 | 3.960 |
| | 05/11 | 72 | 105 | 4 | 96.2 | 3.810 |
| | 05/17 | 24 | 102 | 0 | 100.0 | 0.000 |
| | | Total | 507 | 12 | 97.6 | 2.367 |

Table 9. Total number of coho captured and released at the Black Creek enumeration fence, 1994.

| Category | Number captured | Number sacrificed for sampling | Number released | | |
|---|---|---|---|---|---|
| | | | Tagged | Untagged | Total |
| Male | 303 | 1 | 301 | 1 | 302 |
| Female | 260 | 0 | 259 | 1 | 260 |
| Adult (M + F) | 563 | 1 | 560 | 2 | 562 |
| Jacks | 1265 | 38 | 1225 | 2 | 1227 |

M = male, F = female

Table 10 Summary of foot survey and electrofishing efforts at Black Creek, by date and stratum, 1994.

| Date | Stratum[1] | Method[2] | Distance sampled (m) |
|---|---|---|---|
| 11/15 | F | FS | 500 |
| 11/15 | E | FS | 500 |
| 11/15 | D | FS | 750 |
| 11/16 | A | FS | 500 |
| 11/16 | C | FS | 500 |
| 11/16 | B | FS | 500 |
| 11/17 | D | EF | 500 |
| 11/17 | C | EF | 500 |
| 11/18 | F | EF | 500 |
| 11/24 | F | EF | 750 |
| 11/25 | D | EF | 250 |
| 11/25 | E | EF | 500 |
| 11/30 | D | EF | 1000 |
| 12/01 | F | FS | 500 |
| 12/03 | D | EF | 500 |
| 12/05 | C | FS | 500 |
| 12/06 | C | EF | 500 |
| 12/06 | A | EF | 250 |
| 12/09 | F | FS | 750 |
| 12/09 | D | FS | 1250 |
| 12/10 | C | FS | 750 |
| 12/12 | A | FS | 250 |
| 12/15 | F | FS | 500 |
| 12/15 | D | EF | 250 |
| 12/20 | F | FS | 500 |
| 12/23 | F | FS | 250 |
| 12/23 | D | FS | 500 |

[1]see Figure 1 for stratum locations

[2]FS = foot survey; EF = electrofishing survey

Table 11. Escapement estimates for adult and jack coho for Black Creek, 1994. Estimates provided were derived from mark-recapture data (pooled Petersen estimate) and observed counts (minimum estimate). Final escapement estimates for 1994 are different than these estimates.[1]

| Estimator | Category | N | Lower 95% CL[2] | Upper 95% CL[2] |
|---|---|---|---|---|
| Pooled Petersen | | | | |
| | Adult | 1144 | 831 | 1458 |
| | Jack | 2083 | 1296 | 2870 |
| Minimum (above fence)[3] | | | | |
| | Adult | 599 | N/A | N/A |
| | Jack | 1274 | N/A | N/A |

[1]the final 1994 escapement estimates of adult and jack coho to Black Creek were 900 and 1500, respectively (see text; RESULTS/Coho Population Estimates)

[2]95% CLs calculated using the Chapman hypergeometric model (Seber 1982)

[3]the minimum (known) escapement above the fence is the number of fish released at the fence plus the number of new fish (untagged and no tag loss) handled upstream (both live and dead)

Table 12. Summary of length data from new[1] live coho captured at the enumeration fence and upstream at Black Creek, 1994.

| | Sample size | | | Length (mm)[2] | | |
|---|---|---|---|---|---|---|
| Category | Fence | Upstream | Total | Range | Mean | SD |
| Adult males | 303 | 16 | 319 | 250 - 643 | 464 | 66.4 |
| Females | 258 | 18 | 276 | 281 - 644 | 513 | 48.2 |
| Jacks | 1263 | 8 | 1271 | 208 - 347 | 275 | 23.7 |

[1]"new fish" are fish not previously handled at the enumeration fence and are identified by the absence of an operculum tag or tag scar
[2]postorbital-hypural length

Table 13. Sex ratios and chi-square results for new[1] live coho captured at the enumeration fence and upstream at Black Creek, 1994.

| Adult males only | | | | Adult males and jacks | | | |
|---|---|---|---|---|---|---|---|
| Number adult males | Number adult females | Ratio M:F | Chi-square | Number adult males and jacks | Number adult females | Ratio (M+J):F | Chi-square |
| 316 | 275 | 1.15 | 2.71 | 1588 | 275 | 5.77 | 923.96 |

Note: critical value of chi square = 3.84 (df = 1) in all cases
[1]"new fish" are fish not previously handled at the enumeration fence and are identified by the absence of an operculum tag or tag scar

Table 14. Freshwater age distribution of returning adult and jack coho at Black Creek, 1994, as determined from scale pattern analysis.

| | Freshwater age | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Adults | | | | Jacks | | | | (A + J) | |
| | 1 | 2 | Total aged | Total sampled | 1 | 2 | Total aged | Total sampled | Total aged | Total sampled |
| Number | 14 | 0 | 14 | 22 | 35 | 2 | 37 | 44 | 51 | 66 |
| Percent | 100.0 | 0.0 | | | 94.6 | 5.4 | | | | |

Table 15. Estimates of total escapement of adipose-clipped coho to Black Creek, 1994.

| Category | Sample size[1] (A) | Adipose clips[1] (B) | Mark rate (%) (C = B/Ax100) | Population estimate[2] (D) | Percent of population sampled (E = A/Dx100) | Total estimated adipose clips (F = B/AxD) |
|---|---|---|---|---|---|---|
| Male | 316 | 257 | 81.3 | 481 | 65.7 | 391 |
| Female | 275 | 193 | 70.2 | 419 | 65.7 | 294 |
| (M + F) | 591 | 450 | 76.1 | 900 | 65.7 | 685 |
| Jack | 1272 | 1129 | 88.8 | 1500 | 84.8 | 1331 |
| Total | 1863 | 1579 | 84.8 | 2400 | 77.6 | 2034 |

[1] from all new live fish handled at the fence and upstream; includes fish sacrificed at the fence

[2] population estimates are the final 1994 escapement estimates of adult and jack coho to Black Creek (see Table 11 and text; RESULTS/Coho Population Estimates); adult male and female estimates are derived using the adult male:female ratio in the live sample (composition was 53.5% adult male and 46.5% female)

Table 16. Contribution of 1993 and 1994 coho smolt migrations, by tag code and tagging dates, to the 1994 escapement to Black Creek.

## 1994 ADULTS

| Smolt year | CWT code[1] | Tagging dates | Size at release (mm) | Decoded adipose clips M | Decoded adipose clips F | Decoded adipose clips T | Estimated adipose clips[2] M | Estimated adipose clips[2] F | Estimated adipose clips[2] T[3] | No. Smolts Clipped | No. Smolts Unclipped | Contribution to escapement M | Contribution to escapement F | Contribution to escapement T[4] | Smolt to 1994 adult[5] escapement[6] (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 081835 | 04/23 - 05/18 | <120 | 0 | 1 | 1 | 0.0 | 29.4 | 29.4 | 8261 | 57 | 0 | 30 | 30 | 0.36 |
| | 080141 | 05/19 - 05/22 | <120 | 1 | 2 | 3 | 43.5 | 58.8 | 102.3 | 8296 | 11 | 44 | 59 | 102 | 1.23 |
| | 080143 | 05/23 - 05/27 | <120 | 1 | 2 | 3 | 43.5 | 58.8 | 102.3 | 9725 | 26 | 44 | 59 | 103 | 1.05 |
| | 080144 | 05/28 - 06/15 | <120 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 6429 | 24 | 0 | 0 | 0 | 0.00 |
| | | Total | | 2 | 5 | 7 | 87.0 | 147.0 | 233.9 | 32711 | 118 | 87 | 147 | 235 | 0.71 |
| | 081834 | 04/23 - 05/15 | >=120 | 1 | 0 | 1 | 43.5 | 0.0 | 43.5 | 8758 | 153 | 44 | 0 | 44 | 0.50 |
| | 081836 | 05/16 - 05/20 | >=120 | 3 | 2 | 5 | 130.5 | 58.8 | 189.2 | 9586 | 12 | 131 | 59 | 189 | 1.97 |
| | 080142 | 05/21 - 06/15 | >=120 | 3 | 3 | 6 | 130.5 | 88.2 | 218.6 | 4510 | 27 | 131 | 89 | 220 | 4.85 |
| | | Total | | 7 | 5 | 12 | 304.4 | 147.0 | 451.4 | 22854 | 192 | 306 | 148 | 454 | 1.97 |
| | | Total decoded | | 9 | 10 | 19 | 391 | 294 | 685 | 55565 | 310 | 393 | 295 | 688 | 1.23 |
| | | Strays | | 0 | 0 | 0 | | | | | | | | | |
| | | No data | | 247 | 182 | 429 | | | | | | | | | |
| | | No pin | | 1 | 1 | 2 | | | | | | | | | |
| | | Lost pin | | 0 | 0 | 0 | | | | | | | | | |
| | | Total observed | | 257 | 193 | 450 | | | | | | | | | |

Table 16. Contribution of 1993 and 1994 coho smolt migrations, by tag code and tagging dates, to the 1994 escapement to Black Creek. (cont.)

## 1994 JACKS

| Smolt year | CWT code | Tagging dates | Size at release (mm) | Decoded adipose clips M | Decoded adipose clips F | Decoded adipose clips T | Estimated adipose clips[2] M | Estimated adipose clips[2] F | Estimated adipose clips[2] T[3] | No. Smolts Clipped | No. Smolts Unclipped | Contribution to escapement M | Contribution to escapement F | Contribution to escapement T[4] | Smolt to 1994 jack escapement (percent)[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 080149 | 04/22 - 05/05 | <120 | 3 | 0 | 3 | 95.1 | 0.0 | 95.1 | 8305 | 6 | 95 | 0 | 95 | 1.15 |
| | 080154 | 05/06 - 05/08 | <120 | 2 | 0 | 2 | 63.4 | 0.0 | 63.4 | 9685 | 2 | 63 | 0 | 63 | 0.65 |
| | 080155 | 05/09 - 05/13 | <120 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 10121 | 2 | 0 | 0 | 0 | 0.00 |
| | 080157 | 05/14 - 05/19 | <120 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 8919 | 11 | 0 | 0 | 0 | 0.00 |
| | 080158 | 05/20 - 06/03 | <120 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 4634 | 17 | 0 | 0 | 0 | 0.00 |
| | | Total | | 5 | 0 | 5 | 158.5 | 0.0 | 158.5 | 41664 | 38 | 159 | 0 | 159 | 0.38 |
| | 080145 | 04/22 - 05/02 | >=120 | 16 | 0 | 16 | 507.2 | 0.0 | 507.2 | 10817 | 6 | 507 | 0 | 507 | 4.69 |
| | 080147 | 05/03 - 05/05 | >=120 | 11 | 0 | 11 | 348.7 | 0.0 | 348.7 | 8983 | 4 | 349 | 0 | 349 | 3.88 |
| | 080148 | 05/06 - 05/12 | >=120 | 6 | 0 | 6 | 190.2 | 0.0 | 190.2 | 9728 | 14 | 190 | 0 | 190 | 1.96 |
| | 080156 | 05/13 - 06/03 | >=120 | 4 | 0 | 4 | 126.8 | 0.0 | 126.8 | 6680 | 13 | 127 | 0 | 127 | 1.90 |
| | | Total | | 37 | 0 | 37 | 1172.9 | 0.0 | 1172.9 | 36208 | 37 | 1174 | 0 | 1174 | 3.24 |
| | | Total decoded | | 42 | 0 | 42 | 1331 | 0 | 1331 | 77872 | 75 | 1332 | 0 | 1332 | 1.71 |
| | | Strays | | 0 | 0 | 0 | | | | | | | | | |
| | | No data | | 1080 | 0 | 1080 | | | | | | | | | |
| | | No pin | | 5 | 0 | 5 | | | | | | | | | |
| | | Lost pin | | 2 | 0 | 2 | | | | | | | | | |
| | | Total observed | | 1129 | 0 | 1129 | | | | | | | | | |

abbreviations are: M = male, F = female

[1]1993 CWT release data from Nelson et al. (1995)

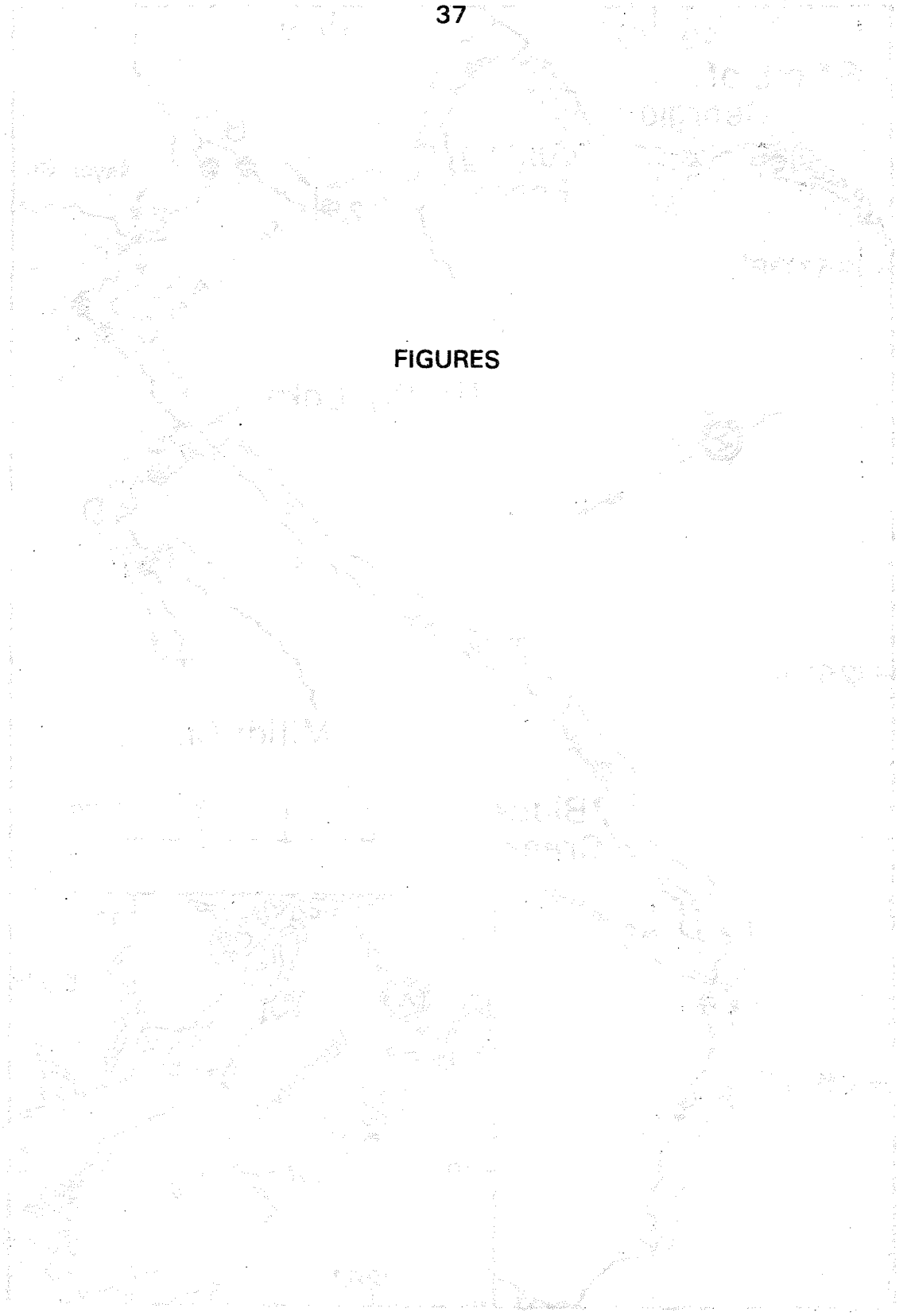
[2]total decoded estimated adipose clips are from Table 15

[3]calculated from observed adipose clips totals

[4]calculated from estimated adipose clips totals

[5]male and female combined

[6]escapement is defined as the number of fish that escaped the marine fisheries and returned to Black Creek



FIGURES

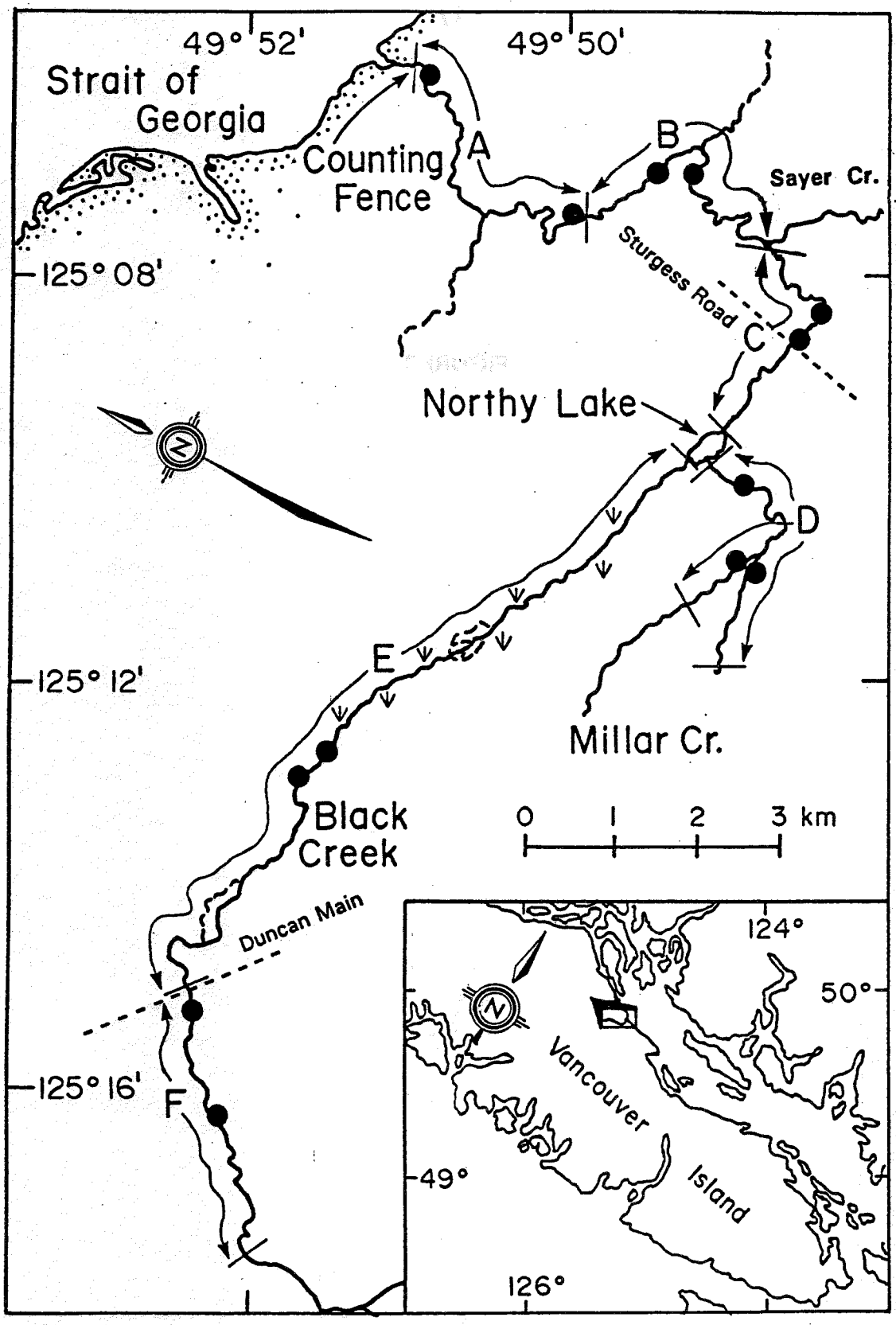



Figure 1. Map of Black Creek study area, showing location of smolt and adult counting fences, upstream recovery strata (A-F), and index reaches (identified by black dots).

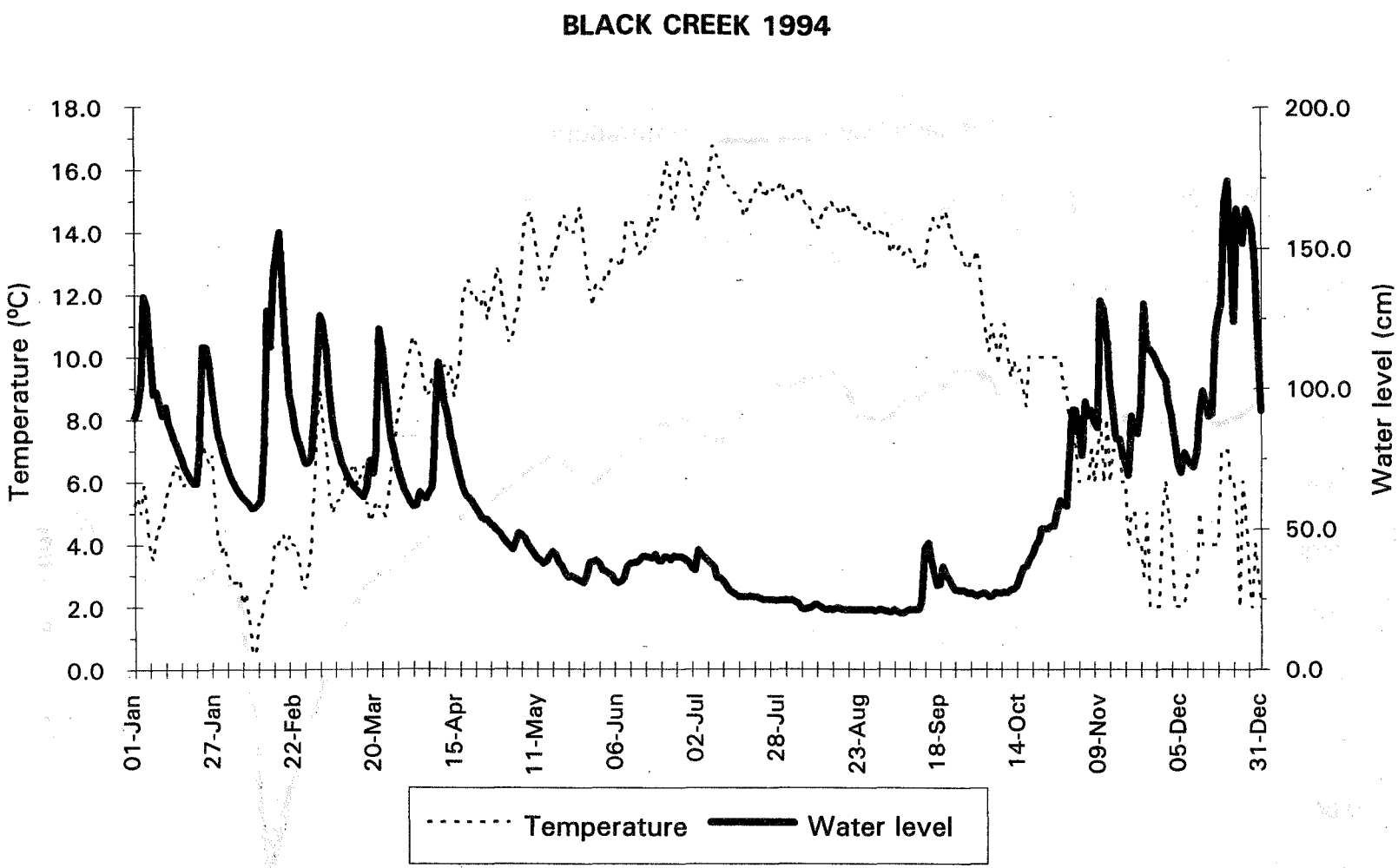



Figure 2. Water temperatures and levels at Black Creek, 1994. Data for Jan. 1 - Oct. 16 are daily means of records logged every three hours on the automated datalogger located 200 m upstream of the Seaview Road Bridge; data for Oct. 17 - Dec. 31 are manual records adjusted to the datalogger scale.

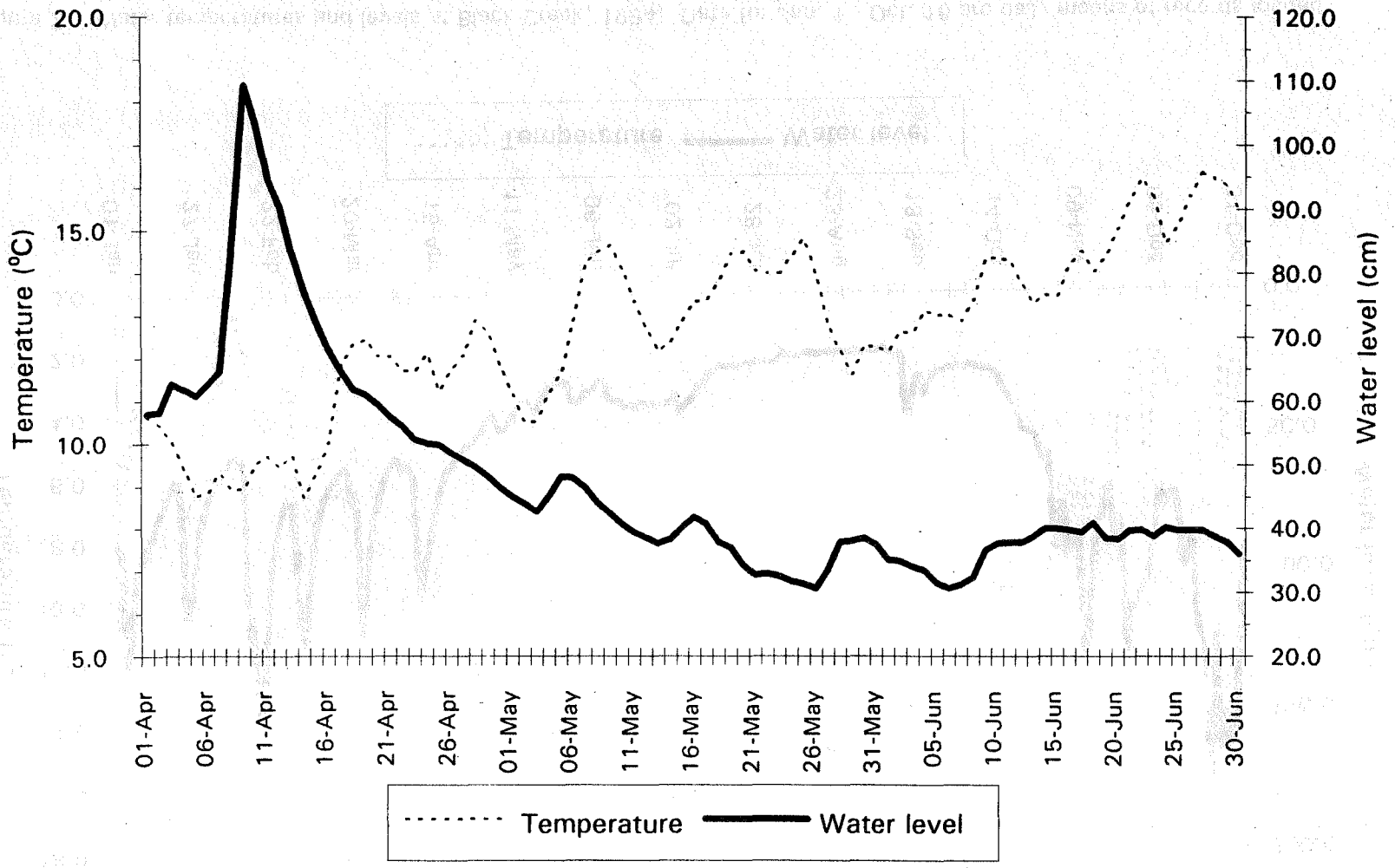



Figure 3. Water temperatures and levels at Black Creek during April, May, and June, 1994. Data are daily means of records logged every three hours on the automated datalogger located 200 m upstream of the Seaview Road Bridge.

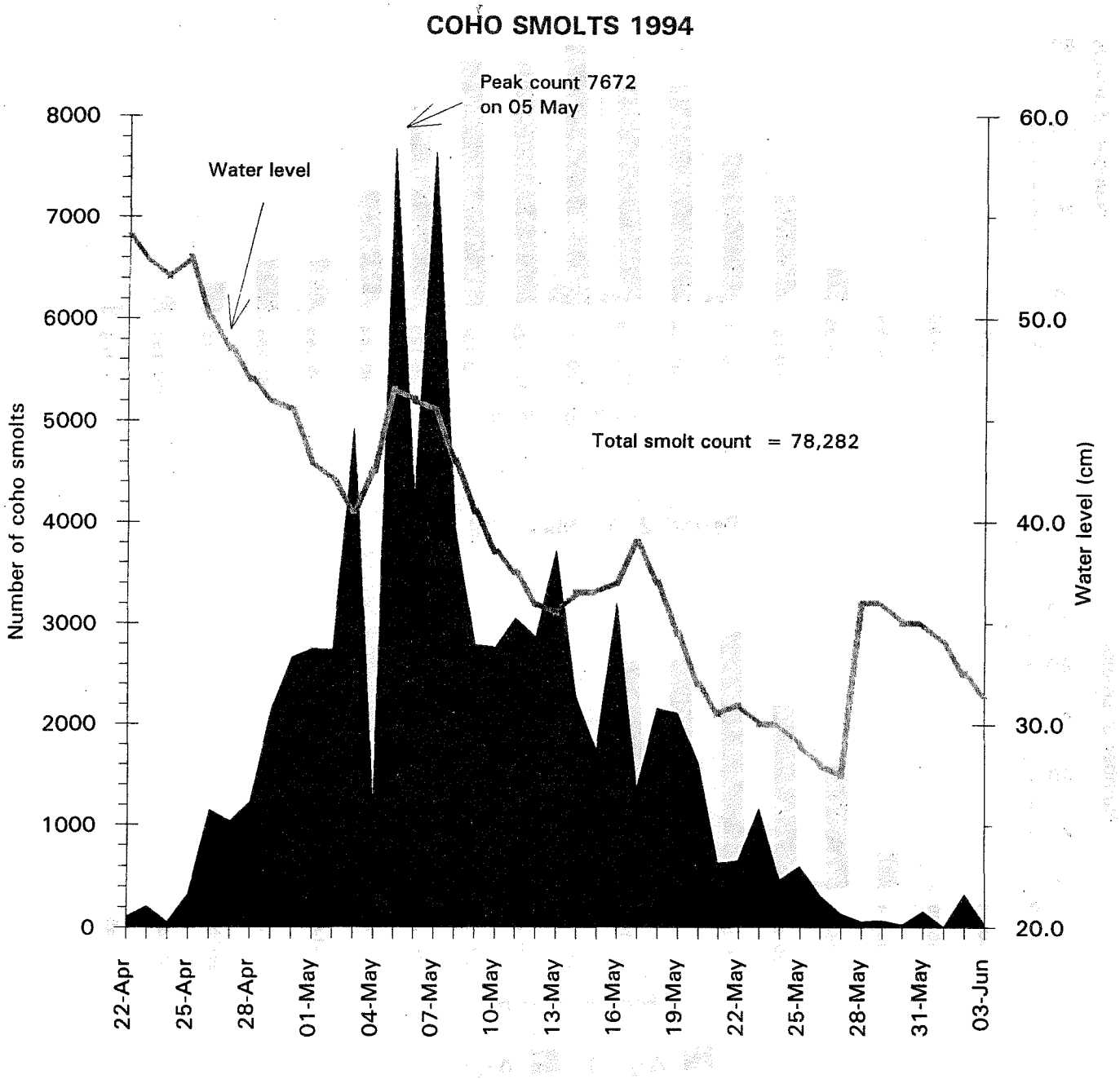



Figure 4. Total daily catches of coho smolts at the enumeration fence, and associated water levels, by date, at Black Creek, 1994.

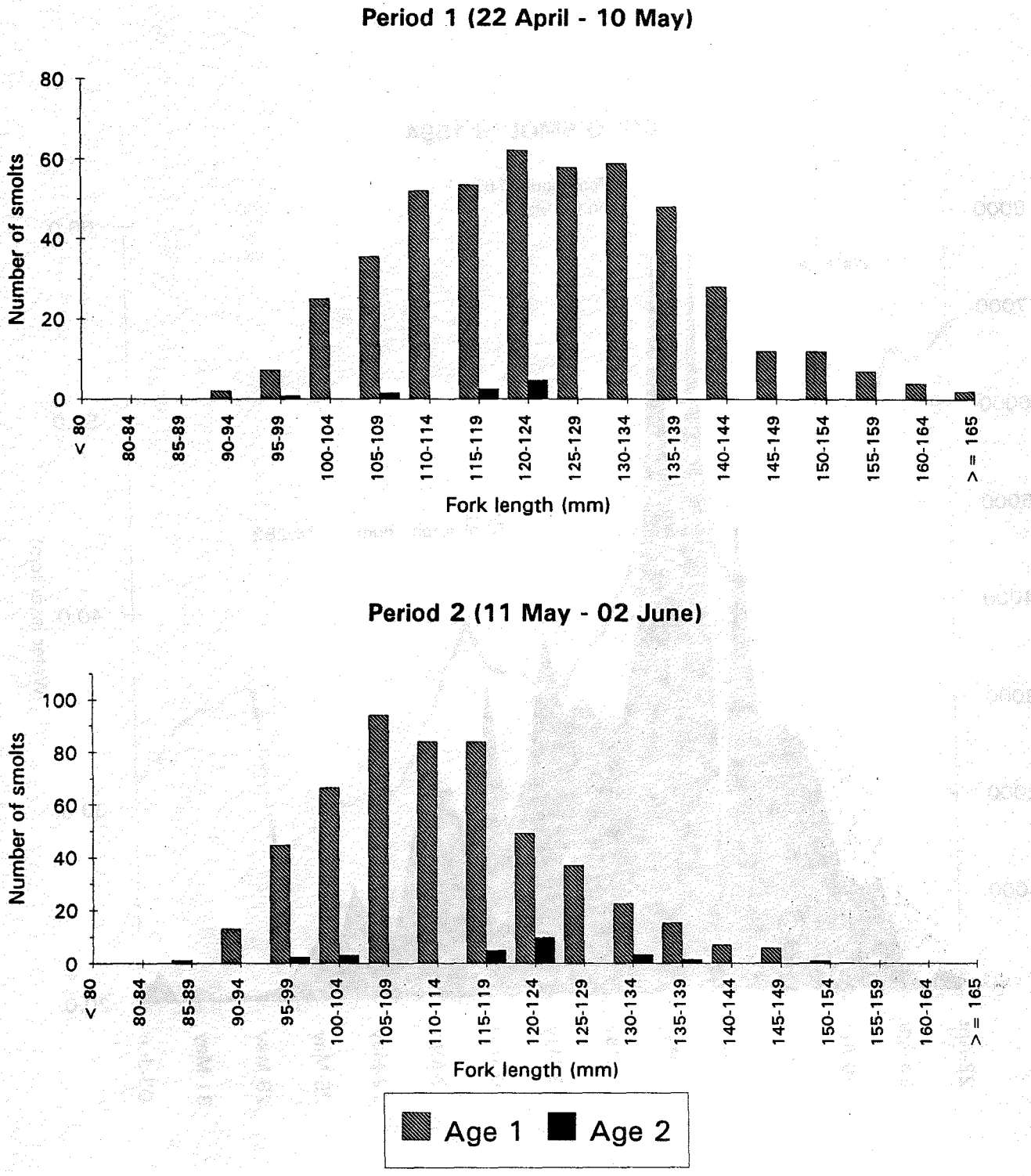



Figure 5. Calculated age-length representation of age-1 and age-2 coho smolts, by sampling period, at Black Creek, 1994. (Data from Table 5.)

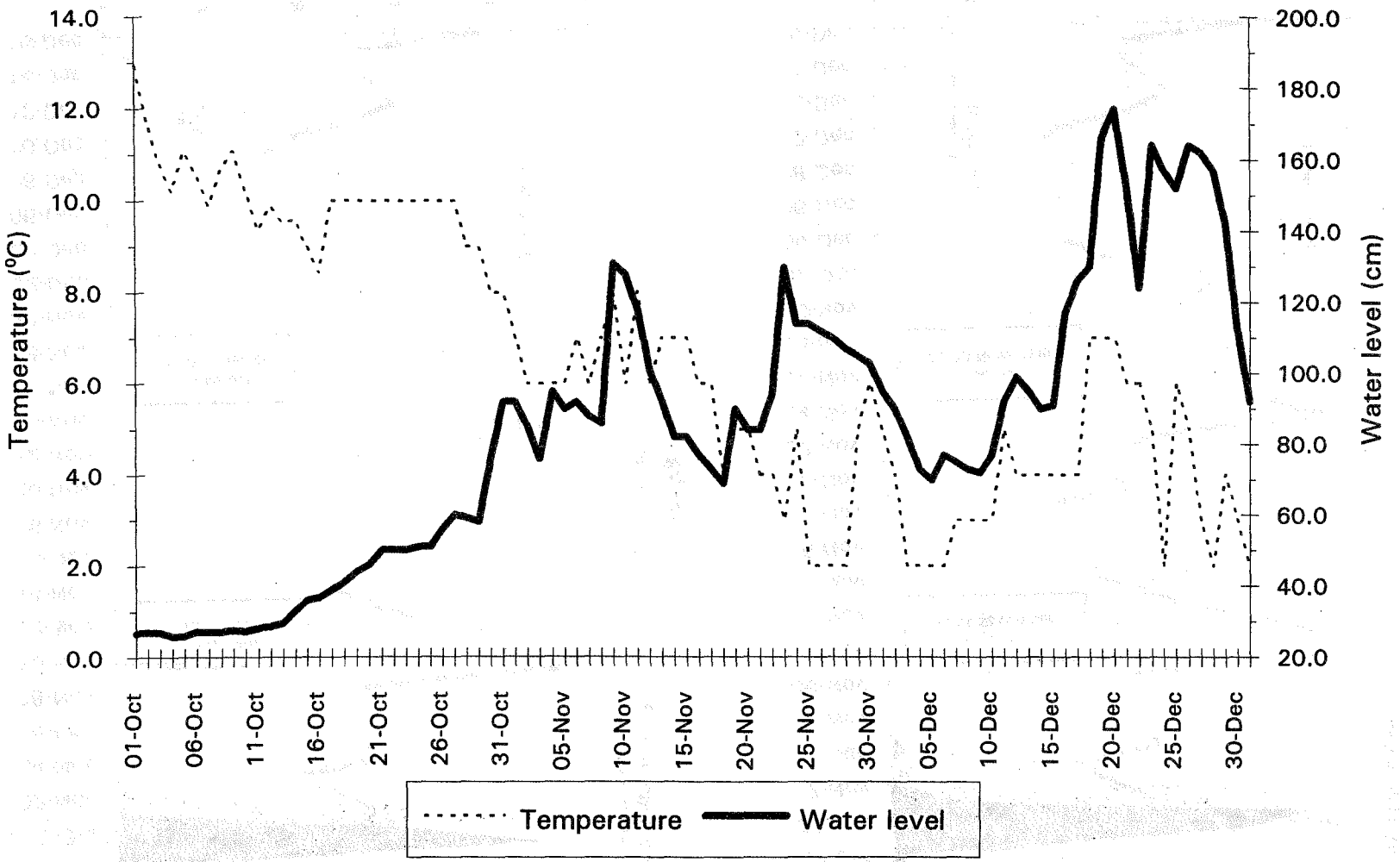



Figure 6. Water temperatures and levels at Black Creek during October, November, and December, 1994. Data for Oct. 1 - 16 are daily means of records logged every three hours on the automated datalogger located 200 m upstream of the Seaview Road Bridge; data for Oct. 17 - Dec. 31 are manual records adjusted to the datalogger scale.

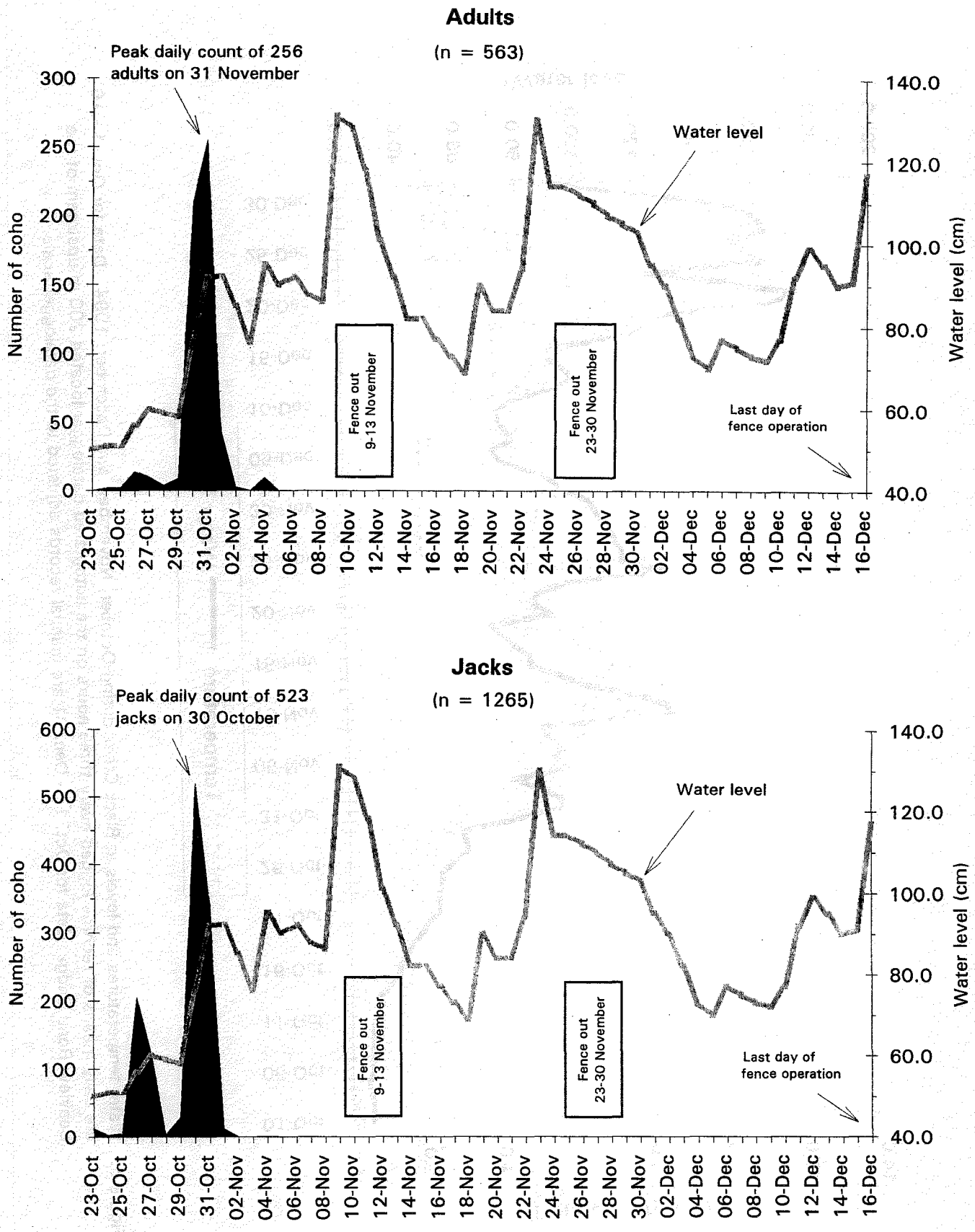



Figure 7. Daily fence counts of adult and jack coho salmon, and associated water levels, during the period of fence operation (23 October through 16 December), by date, at Black Creek, 1994. No fish were observed at the fence after 4 November 1994.

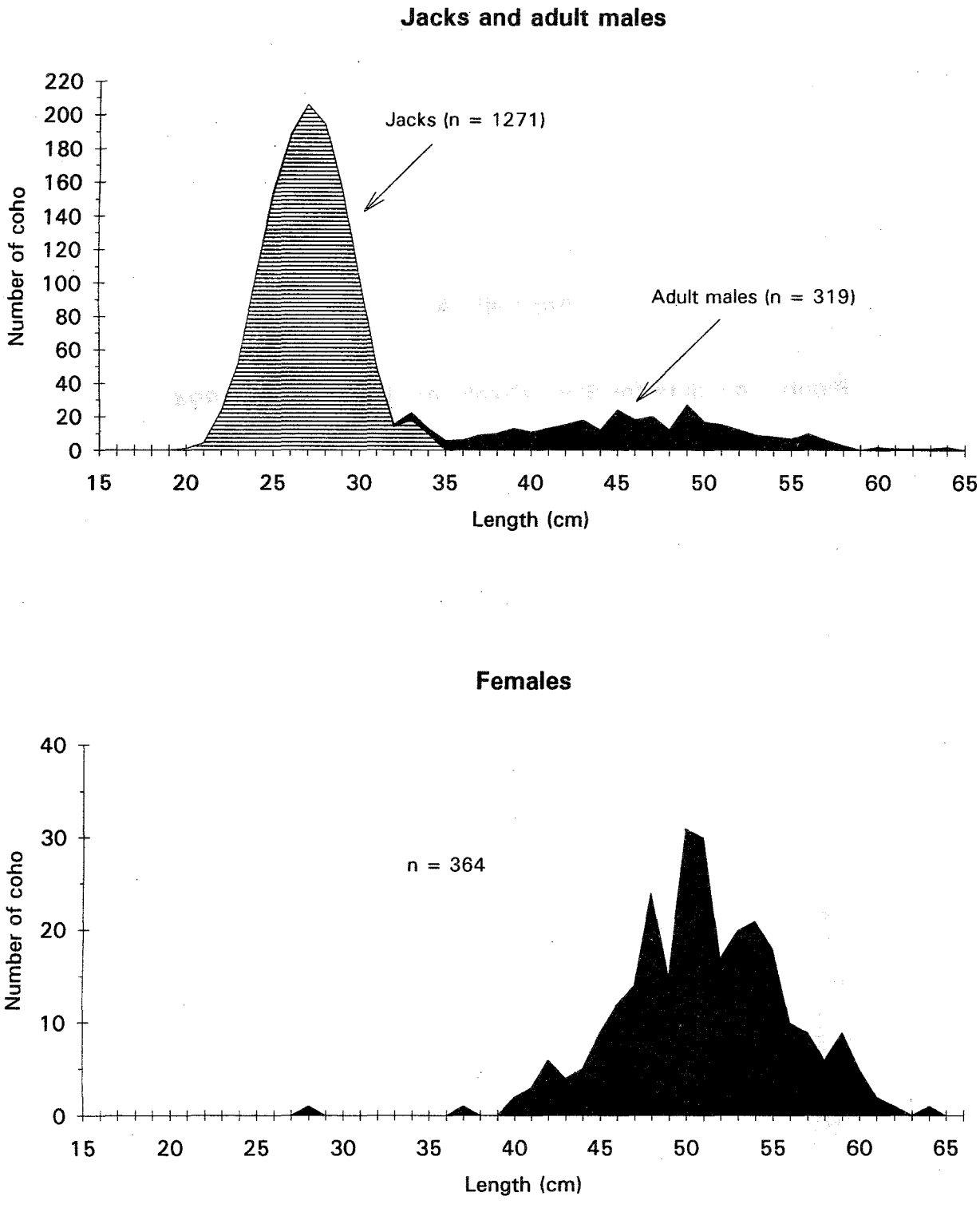



Figure 8. Length-frequency histograms for returning coho salmon at Black Creek, 1994, from all live recovery data of new fish.

# Appendix A

## Biophysical data for Black Creek, April 22-June 3, 1994.

Appendix A. Biophysical data for Black Creek, April 22 - June 03, 1994. Temperature and water level data are daily means of records logged every three hours on the automated datalogger located 200 m upstream of the Seaview Road Bridge. Time entries indicate the time of day when records for rain, wind direction, wind speed, and cloud cover were recorded.

| Date | Time (24 h) | Water Temperature (°C) | Water level (cm) | Rain (0-5) | Wind direction | Wind speed (km/h) | Cloud cover (%) |
|---|---|---|---|---|---|---|---|
| 04/22/94 | 08:00 | 11.7 | 56.0 | 0 | | | 5 |
| 04/23/94 | 08:00 | 11.7 | 54.0 | 0 | | | 5 |
| 04/24/94 | 09:00 | 12.1 | 53.4 | 1 | | | 100 |
| 04/25/92 | 08:30 | 11.2 | 53.1 | 0 | NW | 10 | 20 |
| 04/26/94 | 09:00 | 11.7 | 51.8 | 1 | SE | 10 | 75 |
| 04/27/94 | 09:00 | 12.1 | 50.7 | 0 | | | 5 |
| 04/28/94 | 08:00 | 12.9 | 49.6 | 0 | | 0 | 10 |
| 04/29/94 | 08:30 | 12.6 | 48.2 | 0 | NW | 5 | 92 |
| 04/30/94 | 08:00 | 11.8 | 46.5 | 0 | | | 10 |
| 05/01/94 | 08:00 | 11.1 | 45.0 | 0 | | | 92 |
| 05/02/94 | 08:00 | 10.5 | 44.0 | 0 | | | 12 |
| 05/03/94 | 07:30 | 10.5 | 42.6 | 0 | | | 14 |
| 05/04/94 | 08:00 | 11.2 | 45.1 | 5 | | | 100 |
| 05/05/94 | 08:00 | 11.6 | 48.2 | 0 | | | 6 |
| 05/06/94 | 08:00 | 12.9 | 47.9 | 0 | | | 6 |
| 05/07/94 | 08:00 | 14.2 | 46.5 | 0 | | 5 | 3 |
| 05/08/94 | 08:00 | 14.5 | 44.1 | 0 | | | 4 |
| 05/09/94 | 08:00 | 14.7 | 42.5 | 0 | | | 82 |
| 05/10/94 | 08:00 | 14.1 | 40.7 | 0 | | | 99 |
| | Mean | 12.3 | 47.9 | | | | |
| | Max | 14.7 | 56.0 | | | | |
| | Min | 10.5 | 40.7 | | | | |
| 05/11/94 | 08:00 | 13.3 | 39.4 | 0 | | | 25 |
| 05/12/94 | 08:00 | 12.7 | 38.5 | 0 | | | 32 |
| 05/13/94 | 08:00 | 12.2 | 37.6 | 0 | | | 62 |
| 05/14/94 | 08:30 | 12.4 | 38.4 | 0 | | | 71 |
| 05/15/94 | 07:30 | 12.9 | 40.1 | 0 | | | 84 |
| 05/16/94 | 08:00 | 13.3 | 41.8 | 1 | | | 100 |
| 05/17/94 | 08:00 | 13.4 | 40.7 | 0 | NW | 5 | 44 |
| 05/18/94 | 08:00 | 13.8 | 37.8 | 0 | | | 5 |
| 05/19/94 | 08:00 | 14.5 | 36.9 | 0 | | | 3 |
| 05/20/94 | 08:00 | 14.5 | 34.3 | | | | |
| 05/21/94 | 08:00 | 14.1 | 32.6 | 0 | SE | 2 | 90 |
| 05/22/94 | 08:00 | 14.0 | 32.9 | 0 | | | 4 |
| 05/23/94 | 08:00 | 14.0 | 32.5 | 0 | | | 3 |
| 05/24/94 | 08:00 | 14.4 | 31.8 | 0 | | | 86 |

Appendix A. (cont.) Biophysical data for Black Creek, April 22 - June 03, 1994. Temperature and water level data are daily means of records logged every three hours on the automated datalogger located 200 m upstream of the Seaview Road Bridge. Time entries indicate the time of day when records for rain, wind direction, wind speed, and cloud cover were recorded.

| Date | Time (24 h) | Water Temperature (°C) | Water level (cm) | Rain (0-5) | Wind direction | Wind speed (km/h) | Cloud cover (%) |
|---|---|---|---|---|---|---|---|
| 05/25/94 | 08:00 | 14.8 | 31.3 | 0 | | | 92 |
| 05/26/94 | 08:00 | 14.0 | 30.6 | 0 | | | 6 |
| 05/27/94 | 08:00 | 12.8 | 33.5 | 0 | | | 12 |
| 05/28/94 | 08:00 | 12.2 | 37.9 | 1 | NW | 5 | 100 |
| 05/29/94 | 08:00 | 11.6 | 38.1 | 0 | | | 69 |
| 05/30/94 | 08:00 | 12.3 | 38.5 | 0 | | | 42 |
| 05/31/94 | 08:00 | 12.3 | 37.5 | 0 | | | 86 |
| 06/01/94 | 08:00 | 12.2 | 35.1 | 0 | | | 12 |
| 06/02/94 | 08:00 | 12.6 | 34.9 | 0 | | | 31 |
| | Mean | 13.2 | 36.2 | | | | |
| | Max | 14.8 | 41.8 | | | | |
| | Min | 11.6 | 30.6 | | | | |
| 06/03/94 | 08:00 | 12.6 | 34.0 | 0 | | | 37.0 |

## Appendix B

Catches of juvenile coho at the Black Creek counting fence, by date, 1994.

Appendix B. Catches of juvenile coho at the Black Creek counting fence, by date, 1994.

| Capture date | Total fry catch[1] | Total smolt catch[1] | Total pre-tag fry morts[2] | Total pre-tag smolt morts[2] | Total No. fry released untagged[3] | Total No. smolt released untagged[3] | No. fry available for tagging[4] | Total No. smolts available for tagging[4] |
|---|---|---|---|---|---|---|---|---|
| 04/22/94 | 0 | 104 | 0 | 6 | 0 | 0 | 0 | 98 |
| 04/23/94 | 0 | 210 | 0 | 1 | 0 | 0 | 0 | 209 |
| 04/24/94 | 0 | 56 | 0 | 1 | 0 | 0 | 0 | 55 |
| 04/25/94 | 0 | 326 | 0 | 0 | 0 | 0 | 0 | 326 |
| 04/26/94 | 0 | 1139 | 0 | 2 | 0 | 0 | 0 | 1137 |
| 04/27/94 | 0 | 1031 | 0 | 0 | 0 | 1 | 0 | 1030 |
| 04/28/94 | 0 | 1225 | 0 | 1 | 0 | 2 | 0 | 1222 |
| 04/29/94 | 0 | 2134 | 0 | 6 | 0 | 0 | 0 | 2128 |
| 04/30/94 | 0 | 2663 | 0 | 1 | 0 | 1 | 0 | 2661 |
| 05/01/94 | 0 | 2747 | 0 | 3 | 0 | 1 | 0 | 2743 |
| 05/02/94 | 0 | 2737 | 0 | 3 | 0 | 3 | 0 | 2731 |
| 05/03/94 | 0 | 4915 | 0 | 6 | 0 | 0 | 0 | 4909 |
| 05/04/94 | 0 | 1218 | 0 | 4 | 0 | 1 | 0 | 1213 |
| 05/05/94 | 0 | 7672 | 0 | 1 | 0 | 6 | 0 | 7665 |
| 05/06/94 | 0 | 4245 | 0 | 7 | 0 | 4 | 0 | 4234 |
| 05/07/94 | 0 | 7640 | 0 | 9 | 0 | 0 | 0 | 7631 |
| 05/08/94 | 0 | 3938 | 0 | 1 | 0 | 2 | 0 | 3935 |
| 05/09/94 | 2 | 2784 | 0 | 2 | 0 | 2 | 2 | 2780 |
| 05/10/94 | 0 | 2763 | 0 | 4 | 0 | 4 | 0 | 2755 |
| 05/11/94 | 0 | 3046 | 0 | 9 | 0 | 5 | 0 | 3032 |
| 05/12/94 | 0 | 2865 | 0 | 6 | 0 | 1 | 0 | 2858 |
| 05/13/94 | 0 | 3713 | 0 | 2 | 0 | 2 | 0 | 3709 |
| 05/14/94 | 0 | 2272 | 0 | 0 | 0 | 3 | 0 | 2269 |
| 05/15/94 | 5 | 1751 | 0 | 2 | 0 | 1 | 5 | 1748 |
| 05/16/94 | 6 | 3192 | 0 | 17 | 0 | 4 | 6 | 3171 |
| 05/17/94 | 24 | 1376 | 0 | 13 | 0 | 3 | 24 | 1360 |
| 05/18/94 | 0 | 2157 | 0 | 1 | 0 | 3 | 0 | 2153 |
| 05/19/94 | 0 | 2113 | 0 | 3 | 0 | 2 | 0 | 2108 |
| 05/20/94 | 0 | 1619 | 0 | 2 | 0 | 13 | 0 | 1604 |
| 05/21/94 | 0 | 634 | 0 | 0 | 0 | 1 | 0 | 633 |
| 05/22/94 | 0 | 649 | 0 | 3 | 0 | 0 | 0 | 646 |
| 05/23/94 | 0 | 1160 | 0 | 4 | 0 | 0 | 0 | 1156 |
| 05/24/94 | 0 | 470 | 0 | 1 | 0 | 3 | 0 | 466 |

Appendix B. Catches of juvenile coho at the Black Creek counting fence, by date, 1994. (cont.)

| Capture date | Total fry catch[1] | Total smolt catch[1] | Total pre-tag fry morts[2] | Total pre-tag smolt morts[2] | Total No. fry released untagged[3] | Total No. smolt released untagged[3] | No. fry available for tagging[4] | Total No. smolts available for tagging[4] |
|---|---|---|---|---|---|---|---|---|
| 05/25/94 | 0 | 595 | 0 | 0 | 0 | 2 | 0 | 593 |
| 05/26/94 | 0 | 314 | 0 | 2 | 0 | 1 | 0 | 311 |
| 05/27/94 | 0 | 136 | 0 | 0 | 0 | 0 | 0 | 136 |
| 05/28/94 | 0 | 58 | 0 | 4 | 0 | 0 | 0 | 54 |
| 05/29/94 | 0 | 63 | 0 | 1 | 0 | 2 | 0 | 60 |
| 05/30/94 | 0 | 27 | 0 | 2 | 0 | 0 | 0 | 25 |
| 05/31/94 | 0 | 155 | 0 | 1 | 0 | 1 | 0 | 153 |
| 06/01/94 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 8 |
| 06/02/94 | 0 | 328 | 0 | 20 | 0 | 1 | 0 | 307 |
| 06/03/94 | 0 | 34 | 0 | 0 | 0 | 0 | 0 | 34 |
| Total | 37 | 78282 | 0 | 151 | 0 | 75 | 37 | 78056 |

[1]total catch = No. tagged + total pre-tag morts + No. escapees + No. released untagged
[2]total pre-tag morts = trap and predation mortalities + sacrifices
[3]total No. released untagged = No. released untagged (due to poor condition) + No. escapees
[4]No. available for tagging = total catch - pre-tag morts - No. released untagged

# Appendix C

Catches offish other than coho at the Black Creek counting fence, by date, 1994.

Appendix C. Catches of fish other than coho at the Black Creek counting fence, by date, 1994.

| | Steelhead | | | | | | | | Cutthroat | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | fry | parr | smolt no ad | smolt no clip | adult no ad | adult no clip | kelt no ad | kelt no clip | fry | parr | smolt no ad | smolt no clip | adult no ad | adult no clip | kelt no ad | kelt no clip | Cottids | Lamprey | Stickle-back |
| 04/22/94 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 1 | 9 | 0 | 0 |
| 04/23/94 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 0 | 0 | 1 | 3 | 8 | 0 | 0 |
| 04/24/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 2 |
| 04/25/94 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 5 | 0 | 0 | 6 | 11 | 8 | 0 | 2 |
| 04/26/94 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 7 | 0 | 0 | 8 | 22 | 5 | 0 | 4 |
| 04/27/94 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 12 | 0 | 0 | 7 | 25 | 10 | 0 | 0 |
| 04/28/94 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 0 | 11 | 12 | 0 | 0 | 0 | 8 | 16 | 10 | 0 | 7 |
| 04/29/94 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 21 | 0 | 0 | 6 | 17 | 16 | 0 | 3 |
| 04/30/94 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 50 | 0 | 0 | 8 | 18 | 8 | 0 | 4 |
| 05/01/94 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 13 | 0 | 0 | 2 | 8 | 3 | 0 | 2 |
| 05/02/94 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 3 | 7 | 1 | 1 | 11 |
| 05/03/94 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 11 | 0 | 0 | 10 | 10 | 12 | 0 | 2 |
| 05/04/94 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 7 | 0 | 0 | 10 | 2 | 4 | 0 | 0 |
| 05/05/94 | 0 | 0 | 0 | 37 | 0 | 0 | 0 | 2 | 0 | 18 | 0 | 21 | 0 | 0 | 8 | 9 | 16 | 1 | 2 |
| 05/06/94 | 0 | 0 | 0 | 28 | 0 | 0 | 0 | 1 | 0 | 10 | 0 | 10 | 0 | 0 | 5 | 6 | 13 | 1 | 8 |
| 05/07/94 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 1 | 0 | 9 | 0 | 25 | 0 | 0 | 13 | 5 | 22 | 1 | 5 |
| 05/08/94 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 30 | 0 | 0 | 8 | 13 | 6 | 0 | 3 |
| 05/09/94 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 25 | 0 | 0 | 9 | 6 | 18 | 0 | 4 |
| 05/10/94 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 1 | 0 | 19 | 0 | 55 | 0 | 0 | 5 | 6 | 31 | 0 | 5 |
| 05/11/94 | 0 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 27 | 0 | 0 | 10 | 1 | 6 | 0 | 0 |
| 05/12/94 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 | 0 | 0 | 3 | 0 | 8 | 0 | 2 |
| 05/13/94 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 3 | 2 | 12 | 1 | 3 |
| 05/14/94 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 2 | 1 | 6 | 0 | 0 |
| 05/15/94 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 1 | 1 | 4 | 0 | 0 |
| 05/16/94 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 14 | 0 | 1 |
| 05/17/94 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 3 | 0 | 14 | 0 | 1 |
| 05/18/94 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 16 | 0 | 0 | 8 | 1 | 7 | 0 | 3 |
| 05/19/94 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 12 | 0 | 0 | 0 | 9 | 21 | 0 | 0 |
| 05/20/94 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 8 | 0 | 0 | 7 | 0 | 15 | 0 | 1 |
| 05/21/94 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 27 | 1 | 0 |
| 05/22/94 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 1 | 3 | 10 | 0 | 0 |
| 05/23/94 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 5 | 12 | 0 | 1 |
| 05/24/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 | 1 | 0 |
| 05/25/94 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 14 | 0 | 2 |
| 05/26/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 1 |

Appendix C. Catches of fish other than coho at the Black Creek counting fence, by date, 1994. (cont.)

| | Steelhead | | | | | | | | Cutthroat | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | fry | parr | smolt no ad | smolt no clip | adult no ad | adult no clip | kelt no ad | kelt no clip | fry | parr | smolt no ad | smolt no clip | adult no ad | adult no clip | kelt no ad | kelt no clip | Cottids | Lamprey | Stickle-back |
| 05/27/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 14 | 0 | 0 |
| 05/28/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 1 |
| 05/29/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 0 |
| 05/30/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 1 | 0 |
| 05/31/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| 06/01/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| 06/02/94 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| 06/03/94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| Total | 0 | 0 | 7 | 378 | 0 | 0 | 0 | 8 | 6 | 192 | 13 | 422 | 0 | 0 | 157 | 210 | 485 | 8 | 80 |

# Appendix D

## Summary of sequential coded-wire tag applications, by smolt period, tag code, and smolt size, at Black Creek, 1994

Appendix D. Summary of sequential coded-wire tag applications, by smolt period, tag code, and smolt size, at Black Creek, 1994. D3 and D4 are the data-3 and data-4 values as read from coded-wire tags; sequence numbers are the numeric values associated with the D3 and D4 values.

| Date | Period[1] | Tagcode[2] | Size | D3,D4 (s,e)[3] | Sequence (s,e)[4] |
|---|---|---|---|---|---|
| 04/22/94 | 1 | 08-01-45 | LG | 01,56 s | 208 s |
| 05/02/94 | | | | 94,106 e | 13747 e |
| 05/03/94 | | 08-01-47 | LG | 01,122 s | 172 s |
| 05/05/94 | | | | 125,54 e | 11044 e |
| 05/06/94 | | 08-01-48 | LG | 03,112 s | 351 s |
| 05/10/94 | | | | 123,103 e | 10565 e |
| 05/11/94 | 2 | 08-01-48 | LG | 123,104 s | 10575 s |
| 05/12/94 | | | | 87,5 e | 13049 e |
| 05/13/94 | | 08-01-56 | LG | 90,26 s | 13843 s |
| 05/19/94 | | | | 37,58 e | 7379 e |
| 05/20/94 | 3 | 08-01-56 | LG | 36,45 s | 7222 s |
| 06/03/94 | | | | 52,46 e | 5067 e |
| 04/22/94 | 1 | 08-01-49 | SM | 03,52 s | 11241 s |
| 05/05/94 | | | | 126,113 e | 10844 e |
| 05/06/94 | | 08-01-54 | SM | 01,84 s | 152 s |
| 05/08/94 | | | | 81,22 e | 12516 e |
| 05/09/94 | | 08-01-55 | SM | 90,49 s | 13857 s |
| 05/10/94 | | | | 109,121 e | 9390 e |
| 05/11/94 | 2 | 08-01-55 | SM | 109,82 s | 9372 s |
| 05/13/94 | | | | 15,125 e | 1366 e |
| 05/14/94 | | 08-01-57 | SM | 01,75 s | 141 s |
| 05/19/94 | | | | 117,01 e | 11518 e |
| 05/20/94 | 3 | 08-01-58 | SM | 07,05 s | 761 s |
| 06/03/94 | | | | 56,25 e | 6126 e |

[1]smolt periods, used for additional between-year analyses, are as follows:
Period 1 (through May 10);
Period 2 (May 11-19); and
Period 3 (May 20 on)

[2]a complete listing of 1994 sequential coded-wire tag releases at Black Creek, by date, is available from:
R. E. Bailey
Science Branch
Department of Fisheries and Oceans
Pacific Biological Station
Nanaimo, B.C. V9R 5K6

[3]SM = small (<120 mm); LG = large (> =120 mm)

[4]s = start; e = end

# Appendix E

Biophysical data for Black Creek, October 23 - December 16, 1994.

Appendix E. Biophysical data for Black Creek, October 23 - December 19, 1994. Temperature data was recorded at the enumeration fence, and water level data were recorded manually from the staff gauge located 200 m upstream of the Seaview Road Bridge. Time entries indicate the time of day when records for rain, wind direction, wind speed, and cloud cover were recorded.

| Date | Time (24 h) | Water Temperature (°C) | Water level (cm) | Rain (0-5) | Wind direction | Wind speed (km/h) | Cloud cover (%) |
|---|---|---|---|---|---|---|---|
| 10/23/94 | 12:00 | 8.0 | 48.0 | 2 | | | 100 |
| 10/24/94 | 8:00 | 8.0 | 49.0 | 0 | | | 55 |
| 10/25/94 | 8:00 | 8.0 | 49.0 | 0 | SE | 5 | 82 |
| 10/26/94 | 8:00 | 8.0 | 54.0 | 0 | SE | 10 | 100 |
| 10/27/94 | 8:00 | 8.0 | 58.0 | 1 | SE | | 97 |
| 10/28/94 | 8:00 | 7.0 | 57.0 | 0 | | | 62 |
| 10/29/94 | 8:00 | 7.0 | 56.0 | 0 | | | 90 |
| 10/30/94 | 9:00 | 6.0 | 74.0 | 0 | | | 25 |
| 10/31/94 | 7:30 | 6.0 | 90.0 | 1 | SE | 20 | 90 |
| 11/01/94 | 7:00 | 5.0 | 90.0 | 0 | | | 62 |
| 11/02/94 | 8:00 | 4.0 | 83.0 | 0 | | | 5 |
| 11/03/94 | 8:00 | 4.0 | 74.0 | 0 | S | 2 | 96 |
| 11/04/94 | 6:00 | 4.0 | 93.0 | 0 | | | 15 |
| 11/05/94 | 7:30 | 4.0 | 88.0 | 0 | SE | 17 | 100 |
| 11/06/94 | 8:00 | 5.0 | 90.0 | 0 | | | 67 |
| 11/07/94 | 8:00 | 4.0 | 86.0 | 0 | | | 62 |
| 11/08/94 | 8:00 | 5.0 | 84.0 | 1 | SE | 10 | 100 |
| 11/09/94 | 7:00 | 6.0 | 129.0 | 2 | SE | 15 | 100 |
| 11/10/94 | 8:30 | 4.0 | 126.0 | 0 | | | 37 |
| 11/11/94 | 12:00 | 6.0 | 116.0 | 1 | | | 100 |
| 11/12/94 | 11:00 | 4.0 | 99.0 | 0 | | | 12 |
| 11/13/94 | 11:00 | 5.0 | 90.0 | 0 | | | 100 |
| 11/14/94 | 8:00 | 5.0 | 80.0 | 0 | | | 62 |
| 11/15/94 | 8:00 | 5.0 | 80.0 | 1 | | | 100 |
| 11/16/94 | 8:00 | 4.0 | 75.0 | 1 | NW | 15 | 10 |
| 11/17/94 | 8:00 | 4.0 | 71.0 | 0 | NW | 5 | 5 |
| 11/18/94 | 8:30 | 2.0 | 67.0 | 0 | | | 95 |
| 11/19/94 | 7:30 | 3.0 | 88.0 | 5 | NW | 20 | 100 |
| 11/20/94 | 9:30 | 3.0 | 82.0 | 0 | | | 5 |
| 11/21/94 | 8:30 | 2.0 | 82.0 | 0 | | | 100 |
| 11/22/94 | 8:30 | 2.0 | 92.0 | 3 | SE | 30 | 100 |
| 11/23/94 | 8:30 | 1.0 | 128.0 | 0 | | | 60 |
| 11/24/94 | 8:00 | 3.0 | 112.0 | 2 | SE | 20 | 100 |
| 11/25/94 | 8:00 | 0.0 | 112.0 | 1 | | | 100 |
| 11/26/94 | 8:00 | 0.0 | 110.0 | 0 | | | |
| 11/27/94 | 8:00 | 0.0 | 108.0 | 0 | | | |
| 11/28/94 | 8:00 | 0.0 | 105.0 | 1 | | | 100 |
| 11/29/94 | 8:50 | 3.0 | 103.0 | 2 | | | 100 |
| 11/30/94 | 9:00 | 4.0 | 101.0 | 0 | S | 5 | 45 |

Appendix E. (cont.) Biophysical data for Black Creek, October 23 - December 19, 1994. Temperature data was recorded at the enumeration fence, and water level data were recorded manually from the staff gauge located 200 m upstream of the Seaview Road Bridge. Time entries indicate the time of day when records for rain, wind direction, wind speed, and cloud cover were recorded.

| Date | Time (24 h) | Water Temperature (°C) | Water level (cm) | Rain (0-5) | Wind direction | Wind speed (km/h) | Cloud cover (%) |
|---|---|---|---|---|---|---|---|
| 12/01/94 | 10:00 | 3.0 | 93.0 | 0 | | | 32 |
| 12/02/94 | 9:00 | 2.0 | 88.0 | 0 | | | 40 |
| 12/03/94 | 9:00 | 0.0 | 80.0 | 0 | N | 10 | 2 |
| 12/04/94 | 12:00 | 0.0 | 71.0 | 0 | | | 81 |
| 12/05/94 | 10:00 | 0.0 | 68.0 | 0 | NE | 2 | 86 |
| 12/06/94 | 9:00 | 0.0 | 75.0 | 2 | | | 100 |
| 12/07/94 | 10:00 | 1.0 | 73.0 | 0 | | | 55 |
| 12/08/94 | 9:00 | 1.0 | 71.0 | 0 | | | 82 |
| 12/09/94 | 9:30 | 1.0 | 70.0 | 0 | | | 96 |
| 12/10/94 | 9:30 | 1.0 | 75.0 | 2 | SE | 15 | 100 |
| 12/11/94 | 8:30 | 3.0 | 90.0 | 0 | SE | 10 | 93 |
| 12/12/94 | 9:00 | 2.0 | 97.0 | 0 | | | 91 |
| 12/13/94 | 9:00 | 2.0 | 93.0 | 0 | | 5 | 64 |
| 12/14/94 | 10:00 | 2.0 | 88.0 | 0 | SE | 10 | 100 |
| 12/15/94 | 9:00 | 2.0 | 89.0 | 1 | SE | 15 | 100 |
| 12/16/94 | 9:00 | 2.0 | 115.0 | 0 | | | 49 |
| 12/17/94 | 10:00 | 2.0 | 124.0 | 0 | SE | 5 | 70 |
| 12/18/94 | 12:00 | 5.0 | 128.0 | 0 | SE | 15 | 40 |
| 12/19/94 | 10:30 | 5.0 | 164.0 | 3 | SE | 25 | 100 |
| | Mean | 3.5 | 88.5 | | | | |
| | Max | 8.0 | 164.0 | | | | |
| | Min | 0.0 | 48.0 | | | | |

## Appendix F

Black Creek fence enumerations and associated operculum tag release data for returning adult and jack coho salmon, by date, 1994.

Appendix F. Black Creek fence enumerations and associated operculum tag release data for returning adult and jack coho salmon, by date, 1994.

| Date | Number captured | Number adipose clipped | Number sacrificed | Number released untagged | Number released tagged |
|---|---|---|---|---|---|
| **Males** | | | | | |
| 10/23/93 | 0 | 0 | 0 | 0 | 0 |
| 10/24/93 | 1 | 1 | 0 | 0 | 1 |
| 10/25/93 | 2 | 1 | 0 | 0 | 2 |
| 10/26/93 | 10 | 8 | 1 | 0 | 9 |
| 10/27/93 | 8 | 6 | 0 | 0 | 8 |
| 10/28/93 | 3 | 2 | 0 | 0 | 3 |
| 10/29/93 | 2 | 2 | 0 | 0 | 2 |
| 10/30/93 | 118 | 98 | 0 | 1 | 117 |
| 10/31/93 | 132 | 111 | 0 | 0 | 132 |
| 11/01/93 | 21 | 17 | 0 | 0 | 21 |
| 11/02/93 | 1 | 0 | 0 | 0 | 1 |
| 11/03/93 | 0 | 0 | 0 | 0 | 0 |
| 11/04/93 | 5 | 2 | 0 | 0 | 5 |
| 11/05/93 | 0 | **No fish observed at fence after 04 November** | | | |
| 11/06/93 | 0 | Fence dropped 08 Nov. at 23:59 (flood) | | | |
| 11/07/93 | 0 | Fence fishing 14 Nov. at 08:00 | | | |
| 11/08/93 | 0 | Fence dropped 22 Nov. at 23:00 (flood) | | | |
| | | Fence fishing 01 Dec. at 10:00 | | | |
| | | Fence out for season 16 Dec. at 09:00 (flood) | | | |
| Total | 303 | 248 | 1 | 1 | 301 |
| **Females** | | | | | |
| 10/23/93 | 0 | 0 | 0 | 0 | 0 |
| 10/24/93 | 1 | 1 | 0 | 0 | 1 |
| 10/25/93 | 0 | 0 | 0 | 0 | 0 |
| 10/26/93 | 4 | 4 | 0 | 0 | 4 |
| 10/27/93 | 2 | 2 | 0 | 0 | 2 |
| 10/28/93 | 1 | 1 | 0 | 0 | 1 |
| 10/29/93 | 7 | 3 | 0 | 0 | 7 |
| 10/30/93 | 92 | 60 | 0 | 0 | 92 |
| 10/31/93 | 124 | 92 | 0 | 1 | 123 |
| 11/01/93 | 22 | 15 | 0 | 0 | 22 |
| 11/02/93 | 2 | 2 | 0 | 0 | 2 |
| 11/03/93 | 0 | 0 | 0 | 0 | 0 |
| 11/04/93 | 5 | 4 | 0 | 0 | 5 |
| 11/05/93 | 0 | **No fish observed at fence after 04 November** | | | |
| 11/06/93 | 0 | Fence dropped 08 Nov. at 23:59 (flood) | | | |
| 11/07/93 | 0 | Fence fishing 14 Nov. at 08:00 | | | |
| 11/08/93 | 0 | Fence dropped 22 Nov. at 23:00 (flood) | | | |
| | | Fence fishing 01 Dec. at 10:00 | | | |
| | | Fence out for season 16 Dec. at 09:00 (flood) | | | |
| Total | 260 | 184 | 0 | 1 | 259 |

Appendix F. (cont.) Black Creek fence enumerations and associated operculum tag release data for returning adult and jack coho salmon, by date, 1994.

| Date | Number captured | Number adipose clipped | Number sacrificed | Number released untagged | Number released tagged |
|---|---|---|---|---|---|
| **Jacks** | | | | | |
| 10/23/93 | 13 | 12 | 0 | 0 | 13 |
| 10/24/93 | 3 | 3 | 0 | 0 | 3 |
| 10/25/93 | 6 | 5 | 0 | 0 | 6 |
| 10/26/93 | 207 | 186 | 18 | 0 | 189 |
| 10/27/93 | 126 | 112 | 10 | 0 | 116 |
| 10/28/93 | 4 | 3 | 0 | 0 | 4 |
| 10/29/93 | 29 | 25 | 0 | 0 | 29 |
| 10/30/93 | 523 | 471 | 8 | 0 | 515 |
| 10/31/93 | 340 | 294 | 2 | 1 | 337 |
| 11/01/93 | 12 | 9 | 0 | 0 | 12 |
| 11/02/93 | 0 | 0 | 0 | 0 | 0 |
| 11/03/93 | 0 | 0 | 0 | 0 | 0 |
| 11/04/93 | 2 | 2 | 0 | 1 | 1 |
| 11/05/93 | 0 | **No fish observed at fence after 04 November** | | | |
| 11/06/93 | 0 | Fence dropped 08 Nov. at 23:59 (flood) | | | |
| 11/07/93 | 0 | Fence fishing 14 Nov. at 08:00 | | | |
| 11/08/93 | 0 | Fence dropped 22 Nov. at 23:00 (flood) | | | |
| | | Fence fishing 01 Dec. at 10:00 | | | |
| | | Fence out for season 16 Dec. at 09:00 (flood) | | | |
| Total | 1265 | 1122 | 38 | 2 | 1225 |

## Appendix G

Summary of mark-recapture data for coho salmon collected upstream of the counting fence at Black Creek, 1994.

Appendix G. Summary of mark-recapture data for coho salmon collected upstream of the counting fence at Black Creek, 1994. Operculum tags were applied to all new fish and tag loss fish prior to release. Data presented is for live fish only.

| Date | No. captured | No. new fish[1] | No. new fish[1] adipose clipped | No. new fish[1] filament tagged | No primary recaptures[2] | No secondary recaptures[3] | No. sacrificed | No. released |
|---|---|---|---|---|---|---|---|---|
| **Males** | | | | | | | | |
| 12/06/93 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| 12/15/93 | 54 | 0 | 0 | 0 | 54 | 0 | 0 | 54 |
| 12/16/93 | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 8 |
| 12/20/93 | 30 | 0 | 0 | 0 | 30 | 0 | 0 | 30 |
| 12/23/93 | 15 | 1 | 1 | 0 | 14 | 0 | 0 | 15 |
| 12/27/93 | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 8 |
| Total | 118 | 1 | 1 | 0 | 117 | 0 | 0 | 118 |
| **Females** | | | | | | | | |
| 12/06/93 | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 8 |
| 12/15/93 | 17 | 0 | 0 | 0 | 17 | 0 | 0 | 17 |
| 12/16/93 | 6 | 0 | 0 | 0 | 6 | 0 | 0 | 6 |
| 12/20/93 | 12 | 0 | 0 | 0 | 12 | 0 | 0 | 12 |
| 12/21/93 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| 12/23/93 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 5 |
| Total | 52 | 0 | 0 | 0 | 52 | 0 | 0 | 52 |
| **Jacks** | | | | | | | | |
| 12/06/93 | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 8 |
| 12/15/93 | 47 | 3 | 2 | 0 | 44 | 0 | 0 | 47 |
| 12/16/93 | 9 | 0 | 0 | 0 | 9 | 0 | 0 | 9 |
| 12/20/93 | 36 | 3 | 2 | 0 | 32 | 1 | 0 | 36 |
| 12/21/93 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| 12/23/93 | 7 | 0 | 0 | 0 | 7 | 0 | 0 | 7 |
| 12/27/93 | 9 | 0 | 0 | 0 | 9 | 0 | 0 | 9 |
| Total | 118 | 6 | 4 | 0 | 111 | 1 | 0 | 118 |

[1]new fish are fish captured upstream of the fence that do not possess an operculum tag or tag scar (tag loss)

[2]primary recaptures are fish that were initially counted and tagged at the fence (includes tag loss fish)

[3]secondary recaptures are recaptures of fish that were initially counted and tagged upstream of the counting fence (new fish)

# Appendix H

Recovery data for coho salmon recovered as carcasses in Black Creek, by date, 1994.

Appendix H. Recovery data for coho salmon recovered as carcasses in Black Creek, by date, 1994.

| Date | Number recovered | Number new fish[1] recovered | Number new fish[1] ad clipped | Number primary recaptures[2] | Number secondary recaptures[3] | Number new recovered below fence[4] | Number recovered below fence ad clipped[4] |
|---|---|---|---|---|---|---|---|
| **Male** | | | | | | | |
| 11/14/94 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 11/20/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 11/22/94 | 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| 11/30/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 12/04/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 12/05/94 | 3 | 1 | 1 | 1 | 0 | 1 | 1 |
| 12/06/94 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 12/11/94 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Total | 13 | 6 | 3 | 5 | 0 | 1 | 1 |
| **Female** | | | | | | | |
| 11/01/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 11/03/94 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 11/11/94 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 11/16/94 | 2 | 0 | 0 | 1 | 0 | 0 | 0 |
| 11/21/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 11/30/94 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12/03/94 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 12/05/94 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| 12/06/94 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |
| 12/08/94 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 12/11/94 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Total | 14 | 5 | 3 | 4 | 2 | 2 | 2 |

Appendix H. Recovery data for coho salmon recovered as carcasses in Black Creek, by date, 1994. (cont.)

| Date | Number recovered | Number new fish recovered[1] | Number new fish[1] ad clipped | Number primary recaptures[2] | Number secondary recaptures[3] | Number new recovered below fence[4] | Number recovered below fence ad clipped[4] |
|---|---|---|---|---|---|---|---|
| **Jacks** | | | | | | | |
| 10/31/94 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |
| 11/01/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 11/09/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 11/11/94 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |
| 11/18/94 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12/05/94 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 12/06/94 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 12/12/94 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Total | 11 | 2 | 2 | 7 | 0 | 0 | 0 |

[1]new fish are fish captured upstream of the fence that do not possess an operculum tag or tag scar (tag loss)
[2]primary recaptures are fish that were initially counted and tagged at the fence (includes tag loss fish)
[3]secondary recaptures are recaptures of fish that were initially counted and tagged upstream of the counting fence (new fish)
[4]these "new fish" (n = 3) were first collected as carcasses downstream of the counting fence and are not included in the minimum escapement estimate for fish upstream of the counting fence